A Seven-Day Journal

Lord Nuffield and the Steel Makers.

Lord Nuffield, the chairman of Morris Motors, Ltd., a concern which uses very large quantities of British steel, speaking at a dinner on August 16th, accused the British steel makers of having taken advantage of the import duties to put up their prices, which were a third greater than those of foreign competitors. The result was that motor manufacturers were unable to reduce further the prices of their cars. Lord Nuffield went on to say that he thought it was a shame that such a state of things should exist, because the steel makers were hiding under duties which he had helped them to obtain. The steel makers were taking advantage of the duties instead of increasing production and lowering prices. He further suggested that it was time the duty was taken off, so that the price of cars could be reduced, and if the steel makers did not change their methods, he declared, "we will buy our steel outside this country." He added that he wished he were younger in order that he might set up a steel-making plant in this country and put them all out of business. If they (the steel makers) defied him much longer he would go into the steel trade and produce steel at the same price as the foreigner. The steel manufacturers were naturally somewhat disturbed at these allegations, and Mr. A. K. Wilson, the President of the Sheffield Chamber of Commerce, has issued a statement on behalf of that body deploring the implication that the industry had taken advantage of the tariff unfairly to raise prices against the consumer. Another supporter of the steel makers suggested that if Lord Nuffield felt he had a grievance, he had his remedy in an appeal to the Import Duties Advisory Committee. In a leading article in this issue we deal with the present situation in the steel market and indicate the measure of the agreement between the British and Continental industries. That agreement would be a serious obstacle to Lord Nuffield obtaining his steel outside Great Britain.

The Late Professor Henry Adams.

Many of our readers will learn with regret of the death on Tuesday, August 13th, at his residence, "The Cedars," Brockley View, London, of Professor Henry Adams, well known in London as a teacher of engineering, an architect, and a consulting engineer. Professor Adams, who was in his ninetieth year, was the eldest son of the late John Henry Adams, one of the resident engineers during the construction of the North London Railway. He was born in London in March, 1846, and was educated at the City of London College and later at King's College. In 1865 he became for a short time the assistant outdoor manager for Sir W. G. Armstrong and Co. He obtained high academic honours in his examinations and in 1869 he was appointed to the staff of professors at the City of London College, and founded the engineering department. He also lectured in art and surveying at other educational centres and carried on this evening work for thirty-five years, in addition to his daily work at the office. In 1887 he took over his father's engineering practice and also became superintending engineer to William Cory and Son. In 1909 he took into partnership his eldest son. Professor Adams had wide interests and was the inventor of the Adams vortex blast pipe for locomotives. He was chief examiner in engineering for the Board of Education from 1905 to 1910, and was an early member of the Society of Architects and the Royal Sanitary Institute. He was a member of the Institution of Civil Engineers and the Institution of Mechanical Engineers, a Fellow of the Royal Institute of British Architects, and an honorary member of the Institution of Structural Engineers, of which he was a gold medallist.

Liner and Shipping Casualties.

Early on Sunday morning, August 18th, a serious collision took place in fog between the Cunard-White Star liner "Laurentic," of 18,724 gross tons, outward bound from Liverpool on a cruise to the Northern Capitals, and the Blue Star liner "Napier Star," of 10,538 gross tons, proceeding from Liverpool to Glasgow. The collision took place about 40 miles west of the Mersey Bar. The bows of the "Napier Star" came into contact with the "Laurentic" on her starboard side just forward of the foremast and penetrated several feet. Six members of the crew of the "Laurentic" were killed and others injured. The stem of the "Napier Star" was crushed in by the sudden impact, but the damage sustained by the vessel was to some extent minimised by the sharply sloping Maierform bow with which she was recently fitted. The damage occurred principally above the water line, although the forepeak was flooded. As the crew of the "Napier Star" are berthed aft, there were no casualties in that ship. On Friday evening, August 16th, the 13,475 gross tons Donaldson-Atlantic liner "Letitia," homeward bound from Montreal, went aground on the South Briggs Reef off County Down coast, near Orlock Ness, at the southern entrance to Belfast Lough. The "Letitia" was successfully refloated shortly before three o'clock on Tuesday morning, after the ship had been lightened by about 1000 tons by removal of cargo and ballast. Four tugs and a salvage boat were engaged on the work and with the aid of the liner's engines she slipped off the reef at high tide. Later she steamed for Glasgow where she will be dry-docked. A fire broke out in the engine-room of the motor cruising vessel "Elizabeth Allan," off the Lincolnshire Coast, on Monday, but was extinguished by three converted lifeboats which have been equipped with engines and were carrying fire-extinguishing apparatus.

The New Union-Castle Liner Stirling Castle.

On Thursday, August 15th, the "Stirling Castle," the first of two Union-Castle mail, passenger, and cargo motor ships now under construction at Harland and Wolff's Belfast Yard, was launched. The naming ceremony was performed by Mrs. Robertson F. Gibb, the wife of the chairman of the Union-Castle Steamship Company, Ltd. There was a large attendance, which included the Governor of Northern Ireland and several members of the Ulster Cabinet. The new ship is the largest passenger liner launched in Great Britain since the "Queen Mary." She has a measurement of 25,000 gross tons, with an overall length of 725ft., and a beam of 82ft. Provision is being made to carry 300 first-class and 500 cabin-class passengers. A new note in Union-Castle liners will be struck by the adoption of a single funnel. The cargo-carrying capacity will include an insulated capacity of about 330,000 cubic feet, arranged generally for the carriage of deciduous and citrus fruits with other compartments specially designed for chilled and frozen products. The propelling machinery of the new liner will follow the practice adopted in sister ships, and will comprise a twin-screw arrangement of Harland-B. and W. double-acting, two-stroke oil engines, each having ten cylinders, with a diameter of 660 mm. and a stroke of 1500 mm., working on the airless injection principle with uniflow scavenging, and a tuned exhaust system, waste-heat boilers being fitted.

Research in Food Transport and Storage.

The 1934 Report of the Food Investigation Board, just issued by H.M. Stationery Office, describes the work being carried out under the Department of Scientific and Industrial Research on the transport and storage of food. The Report states that the discovery by the Department's research staff that beef can be stored from sixty to seventy days in a chilled state by enriching the air in the store with carbon dioxide has been energetically taken up by New Zealand and Australian interests. In 1934 no less than twelve ships were built or laid down for Australasian trade, and were fitted with chambers for gas storage. Existing ships have also been modified to conform with the new practice. Although the leakage of carbon dioxide gas from ships' holds has been largely overcome, there remain other problems for solution, such as correct stowage to prevent chafing, and the proper conditions as regards humidity, cooling, and air circulation, which are required to preserve to the fullest extent the appearance of the meat. At home the use of gas storage for fruit has been greatly extended, and successful experiments in ripening at artificially raised temperatures have been carried out. An important discovery which seems likely to have considerable application is that wrapping papers treated with iodine retard the development of fungal rotting in various types of fruit without impairing its appearance or flavour or hastening its ripening. Investigations are being carried out to determine more exactly the quantities of ice required to last from the ports to the markets when transporting fish, and important developments in the application of refrigeration to the needs of the herring industry have been recorded.

New Shipbuilding Orders.

At the launch of the two destroyers, H.M.SS. "Greyhound" and "Griffin," which took place at Vickers Armstrong's Barrow-in-Furness Yard on Thursday, August 15th, Sir Charles Craven referred to the placing with the firm by the Argentine Government of an order for a large cruiser and training ship. When the contract was signed and work begun, he said, it would mean employment for some thousands of workpeople for an average of 2½ years. On the Clyde several orders are reported. Haldin and Philipps, Ltd., have placed an order for a motor vessel of 9200 tons deadweight carrying capacity on behalf of the British Steamship Company, Ltd., with Lithgows, Ltd., of Port-Glasgow. The machinery will be supplied by John G. Kincaid and Co., Ltd., of Greenock. Lithgows, Ltd., are also constructing two cargo steamers of 7500 tons deadweight carrying capacity for the Bombay service of Scindia Steamships (London), Ltd. They will be propelled by Kincaid triple-expansion engines. At Whiteinch, Barclay, Curle and Co., Ltd., have received an important order for a 10,000 gross ton passenger and cargo liner for Ellerman Lines, Ltd. The ship will be propelled by geared turbines and will have accommodation for 200 passengers. She is to be ready for service in October, 1936. At Govan, the Fairfield Shipbuilding and Engineering Company, Ltd., has received an order from the London, Midland and Scottish Railway Company for a 250ft., twin-screw, turbine steamer for Clyde service.

A Proposed Southampton Seadrome.

The announcement is made that a new British air transport company is to be formed which will be largely controlled by shipping interests. The centre of the company's operations will be at Southampton, where, in collaboration with the Southern Railway Company, a large seadrome is to be built alongside the King George V Graving Dock. The plan is to make Southampton one of the largest of the world's airports. The machines, it is understood, will all be seaplanes or flying boats with capacities from twelve up to thirty-two passengers. The first mail and passenger service will be in all probability run between Southampton and Copenhagen, while other routes will include services to Lisbon and a branch service to New York *vid* the Azores and Bermuda. Other routes to South America, the Canary Islands, West Africa, and Cape Town are also planned. It is well known that certain shipping companies are feeling keenly the competition of fast air transport. The object with which the new company is to be formed is to promote a close association between sea and air services, and it is understood that it is its intention to engage only mercantile marine and naval officers as pilots for its seaplanes. Fuller particulars of the company and its services are to be made available in October.

A New Road Sign.

A new road sign is shortly to make its appearance on the roads of Great Britain. This is the order "Halt at Major Road Ahead," surmounted, as usual, by the red triangle and circle and written in black letters on a white ground. Unlike many of its forerunners, the sign is a definite order and non-compliance therewith will be an offence under the Road Traffic Act, 1930, Section 49, punishable by a fine of £20. In a letter to the various highway authorities, the Minister of Transport explains that as a general rule the sign should only be placed at cross roads where the driver on the minor road cannot have a clear view of the major road in both directions. It is suggested that in these cases the new sign should replace the existing "Slow—Major Road Ahead" sign, but before erecting the new sign the authorities are asked to seek counsel from the police. The Ministry of Transport is prepared to authorise the use of this sign at crossings which are not "blind." The new sign will be placed close to the junction and in no circumstances more than 30 yards from it, so that drivers will be well advised to keep a very careful lookout for the red triangle among the hedgerows. Thirty yards is just over two seconds' travel at the normal 30 miles per hour.

The Late Mr. Thomas B. Mackenzie.

Engineers in the iron and steel industry have lost a leading member of their profession by the recent death of Mr. Thomas Brown Mackenzie, who, in 1923, retired from the post of chief engineer to David Colville and Sons, Ltd., after a period of service of over twenty-eight years. He was a native of Renfrew and received his education in Glasgow, where he served his apprenticeship with John Norman and Co., of Port Dundas. Later he obtained further experience at the Hyde Park Locomotive Works, Springburn, and returned to his former firm to take charge of the drawing-office after the business had been taken over by J. Copeland and Co. While engaged in the execution of a contract for his firm at Colville's Dalzell Works, the late Mr. David Colville invited him to take charge of the Dalzell drawing-office. He took up this position in 1895. In 1900 Mr. Mackenzie was appointed chief engineer for all new construction, and from that time onward he was largely responsible for the design and remodelling of plant at the various works of the company. The striking increases in capacity and output of the firm's works were largely due to schemes initiated by Mr. Mackenzie. We may particularly mention in this connection the extensions at the Glengarnock and Clydebridge Steel Works, and other improvements. He travelled widely in America and on the Continent in his study of steel-works practice, and had a thorough grasp of the chemical and metallurgical sides of the industry. He became to be looked upon as one of our ablest steel-works engineers. He was a life member of the Institution of Mechanical Engineers, a member of the Iron and Steel Institute, the Institution of Engineers and Shipbuilders in Scotland, and of the West of Scotland Iron and Steel Institute, and an associate of the Institution of Electrical Engineers. He took a deep interest in the historical side of engineering, and frequently wrote for *Colville's Magazine* on such subjects as "The Evolution of the Steam Engine" and "Tools of Our Trade." He was deeply concerned with the welfare and education of young engineers and founded a Mackenzie Trust Fund for providing awards to those who distinguished themselves at evening classes.

Electric Driving.

No. I.

THE readiness with which electric driving is now adopted in all sorts of workshops, particularly those that are newly built, is a sure sign that industrialists recognise its merits. Electric driving is regarded as an essential feature of modern works, irrespective of the class of goods they produce or the place in which they happen to be situated. Where cheap electricity is still unobtainable or where the nature of the work demands the use of process steam the private generating plant still holds its own, and will in all probability long continue to do so. But irrespective of whether current is generated on the premises or is purchased from outside, the electric motor has in most cases much to recommend it. It can be applied to individual machines without the use of overhead shafting and belts. As the power is not transmitted mechanically from a centralised spot, losses are minimised and there is little wear and tear. Machines can be started and stopped with the aid of press buttons located in suitable positions. Motors of suitable types give the requisite speed variation. Power supplied to any particular machine or group of machines or department may readily be measured by meters connected in the circuits, and the effect of changes in processes can therefore be determined. By reason of their simple and robust construction motors cost very little to maintain. The drive, moreover, is free from irregularities. Where required, foundations are light and inexpensive, and if

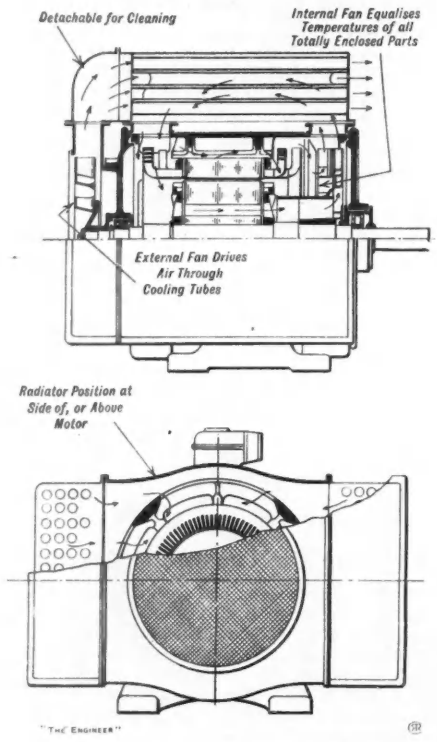

Detachable for Cleaning
Internal Fan Equalises Temperatures of all Totally Enclosed Parts
External Fan Drives Air Through Cooling Tubes
Radiator Position at Side of, or Above Motor
"The Engineer"

FIG. 1—CLOSED AIR CIRCUIT MOTOR

it is necessary to change a motor it is generally a simple and straightforward job.

The effect which the electric drive has had on the lay-out of certain workshops is marked. In the modern machine shop there has been a change from the group drive with its overhead shafting and belting to the individual drive for each machine tool, which has undergone changes in design in consequence. Greater simplicity and more balanced design was obtained by the use of a "built-in motor" made, for example, by the British Thomson-Houston Company, Higgs Motors and the English Electric Company. The motor becomes part of the machine tool, which is simple and compact.

Another step was the introduction of the sectional drive of the machine by the incorporation of a motor for each of the principal motions, a scheme which has resulted generally in simplification of the machine details. Although originally used as a single-speed machine, the squirrel-cage motor has been developed to give two, three, or four speeds by pole changing with the aid of a controller. While D.C. has been largely employed for industrial drives, A.C. is now more or less the standard supply. There is now available for most factories a three-phase 50-cycle supply at 400 or 440 volts, and in many cases the simple squirrel-cage induction motor devoid of brushes and with nothing to wear beyond the bearings meets the requirements. One of its advantages is that it can be changed from full forward speed to full reverse speed in a very short space of time, thus making it particularly suitable for certain processes, such as tapping. The only real disadvantage of the 50-cycle squirrel-cage motor is that its maximum speed is 3000 r.p.m., and while in most cases this is a matter of no importance, certain tools, such as small internal grinders, small drills, and other appliances, used in different industries, demand higher speeds. But the difficulty can be overcome by raising the frequency by a small frequency changer, for a motor which runs at 3000 r.p.m. at 50 cycles will run, for example, at 18,000 r.p.m. when the frequency is raised to 300 cycles. In textile spinning this scheme is largely employed. Thousands of small power spindles run for twenty-four hours per day at 12,000 and 9000 r.p.m., whilst in woodworking works speeds on routing machines

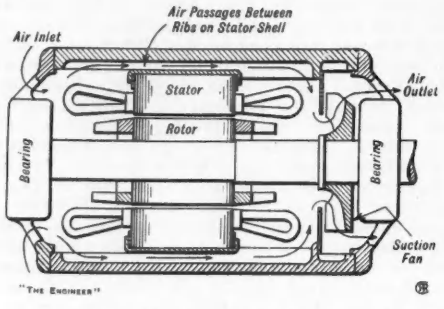


FIG. 2—"BUILT-IN" MOTOR

are as high as 24,000 r.p.m. With the aid of frequency changers it is both possible and economical to obtain frequencies for high-speed motors giving, say, 10,000, 12,000, 18,000, 20,000, or 24,000 r.p.m.

These high-frequency motors are used for drilling very small holes and for internal grindings. Portable electric tools directly connected to the 50-cycle supply are generally driven by high-speed single-phase commutator motors through reduction gears, but owing to the necessity for the commutator and brush gear these motors are less robust than simple squirrel-cage machines. Many of them are, nevertheless, in successful use and they offer the advantage that they can be directly connected to one of the phases of the three-phase system.

But reverting to the larger motors employed for driving machine tools and all sorts of machinery associated with different industries, it is to be noted that, apart from selecting a motor having the correct electrical characteristics for a given job, it is essential to pay attention to the type of enclosure. Motor manufacturers produce motors with different types of enclosures to meet different conditions.

Owing to the ease with which the motor can be arranged close to the driven machine or be incor-

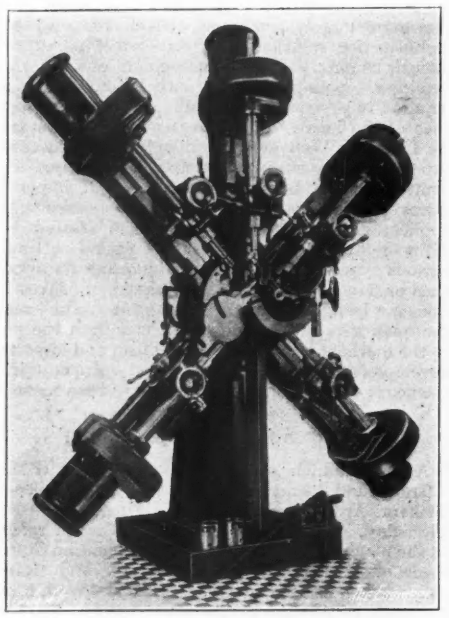


FIG. 3—DRILLING MACHINE WITH FIVE MOTORS

porated within it, the conditions under which the driven machine operates must be withstood by the motor without protection other than that afforded by the motor itself. Motors known as protected, screen protected, pipe ventilated, drip-proof frame-cooled totally enclosed, and totally enclosed machines have been introduced to comply with the various conditions encountered in practice. Of these machines the frame-cooled totally enclosed motor made in slightly different forms by various firms is one of the most interesting and useful. It is specially designed for use in gasworks, chemical works, collieries, quarries, and similar situations in which dust and dirt are prevalent. Because of the need for a large cooling surface a totally enclosed motor to give more than small power continuously had hitherto to have excessive dimensions. But on account of its special ventilating features the frame-cooled totally enclosed machine is considerably smaller.

To take the G.E.C. machine for example, the shell consists of a double wall casing and the annular space between the walls is divided into sections by longitudinal ribs to form ventilating ducts, which are arranged to give separate circuits for internal and external air flow, adjacent ducts being in different circuits. Air is blown round the internal circuit by a fan at the driving end, whilst a second fan forces a continual flow of cool air through the adjacent external ducts. In this way the heat is transferred from the totally enclosed part of the motor to the external ducts and is carried away. By the use of the double circuit ventilating system, exemplified in another case by the English Electric Company "Closvent" machine, all parts of the motor are cooled and there is no possibility of air remaining stationary in any part of the machine. Compared with a pipe-ventilated motor, the machine offers the advantage of eliminating the pipes, which, unless short, are often inconvenient, unsightly, and expensive. Details of the second motor designed by the English Electric Company to combine total enclosure with efficient cooling are given in Fig. 1. Fundamentally this closed air circuit motor comprises a pipe-ventilated type of machine with the inlet and outlet openings connected to a surface-cooled radiator instead of to the outside atmosphere. While total protection is given to the vital parts from the surrounding atmosphere, air driven by the rotor fan is circulated through a closed circuit. The surface-cooled radiators consist of one or more groups of straight tubes welded into end plates and while the heated air within the motor casing passes over the exterior of the tubes a stream of cold outside air is forced continuously through the inside of the tubes by means of a second fan mounted on the non-driving end of the shaft

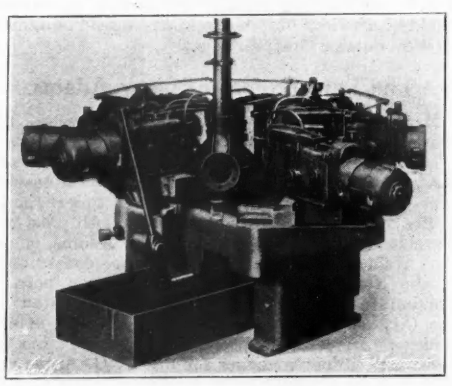


FIG. 4—MULTIPLE MOTOR DRILLING MACHINE

outside the totally enclosed motor casing. By means of an elbow joint between one end of the radiator and fan casing the air is directed through the tubes and as the two streams of air inside and outside the tubes flow in opposite directions, efficient and rapid cooling is maintained. The well-known Emcol motor made by Laurence Scott and Electromotors, Ltd., described in THE ENGINEER of May 18th, 1934, is another machine that combines total enclosure with efficient ventilation.

A section of a B.T.H. "built-in" motor is shown in Fig. 2. Although to a considerable extent ventilation depends upon the duty and speed of the unit, the system of ventilation indicated enables the maximum rating to be obtained, but if the duty is intermittent more restricted ventilation may be employed. The suction fan shown in the drawing draws the air over the end windings and behind the stator core and the high velocity of the currents prevents the passages being choked with foreign matter. The air inlets should obviously be situated where clean air can be drawn in without carrying injurious matter into the motor, and the openings arranged to prevent the entry of chips, dust, shavings, &c. With horizontal motors the ventilating openings should preferably be below the horizontal centre line. As a general rule no screens are required on these motors, which have wound stators in drawn steel shells suitable for building into machine tool frames. The squirrel-cage rotors with cast aluminium conductors are mounted directly on the machine tool shaft, which, like the bearings, end shields and frames, are provided by the machine tool manufacturer.

The higher speeds are usually obtained by using two-pole machines, which on a 50-cycle circuit run at 3000 r.p.m. Higher speeds up to 20,000 r.p.m. are obtained by employing frequency changers as explained. For applications requiring pre-determined speed changes, such as drilling machines, lathes, &c., these "built-in" motors, like those that do not form an integral part of the machine, are supplied as two, three, and four-speed motors. Many "built-in" motors have a long record of trouble-free service. They have a high overload capacity and high speeds

are permissible. Machine tools equipped with them can easily be transferred to the most useful point in the line of production. The machines to which they are fitted are self-contained and the overall cost is reduced. Unhampered by belts and gears, the tool designer can mount the driving unit in positions best suited to the requirements of the cutting tool.

The control equipment of modern electrically driven machine tools covers a wide range of duties, from the simple starting and stopping of a motor by a hand-operated switch to push button automatic control of the whole machine. Control gear for machine tool drives may be of three classes: separately mounted gear, gear mounted on the machine, and gear built into the machine. The first is employed for large machines, although in some cases the machine frame can be adapted to form a contactor panel housing.

Gear mounted on the machine and that built into it is generally applicable to small machines and to certain large machines on which comparatively simple control is required. The principal advantages of gear mounted on the machine and that built into it as compared with separately mounted gear are a saving in floor space and the machine is made a self-contained unit, which can be readily moved to suit the shop lay-out as the nature of the work changes. When the control gear is mounted on the machine the machine tool manufacturer is generally able to employ stock apparatus, and the arrangement usually provides the best accessibility for maintenance. It is also easy to arrange the equipment for convenient operation. But unless care be exercised in the choice of the apparatus and in fitting it to the machine, the general appearance of the tool may be spoilt.

Built-in control gear is gaining ground. It enables space on the tool that would otherwise be wasted to be utilised, and it tends to improve the machine's appearance. On the other hand, it may be difficult to get at it for inspection and maintenance, although this is to a large extent offset by its reliability, which reduces the necessity for inspection.

Largely as the result of progress in the use of the individual motor drive, push button control is now extensively employed. While the buttons are mounted in any small space convenient to the operator, the control equipment is placed on the machine frame or elsewhere. When automatic control is adopted it is usually possible to give more complete protection to the motor than is possible when hand control is employed, and unskilled operators are relieved of responsibility. Push button control enables the utmost advantage to be taken of the operating characteristics of the different types of motors, such as squirrel-cage, slip ring, variable-speed A.C. and D.C. machines.

The increased use of push button control is also attributable to the introduction of machine tools designed to reduce the time required for changing from one operation to another or for setting up. Push button control enables the electrical equipment to be operated at the maximum safe limit and to meet the conditions that have tended to make the duty cycle more arduous. With suitable A.C. or D.C. motors various operations are facilitated. Inching can be done for setting up purposes; tools may be slowed down during part of an operation; or the motor may readily be reversed. Whilst with the line shaft drive it is necessary to obtain the speeds required on different machines by gear-boxes or other mechanical arrangements, the individual drive makes it possible to simplify mechanical gear changes by the use of variable-speed motors. The variable-speed A.C. commutator motor and the change pole squirrel-cage machine have found a wide field of application. In some cases the machine spindle is driven directly from the motor and the speed range is obtained entirely electrically without any mechanical gear.

In drawing this first article to a close, attention may be directed to a few modern examples of electrically operated machine tools, &c. The well nigh impossible task of dealing with drives in all industries cannot be attempted, but an endeavour will be made in subsequent articles to consider the subject in a general way and to reproduce pictures of electrically driven machines selected from an extensive collection placed at our disposal. What is now done in the way of applying a number of motors to a single tool is exemplified by the illustrations Figs. 3–8. The first shows a Pollard drilling machine fitted with five 1 h.p.

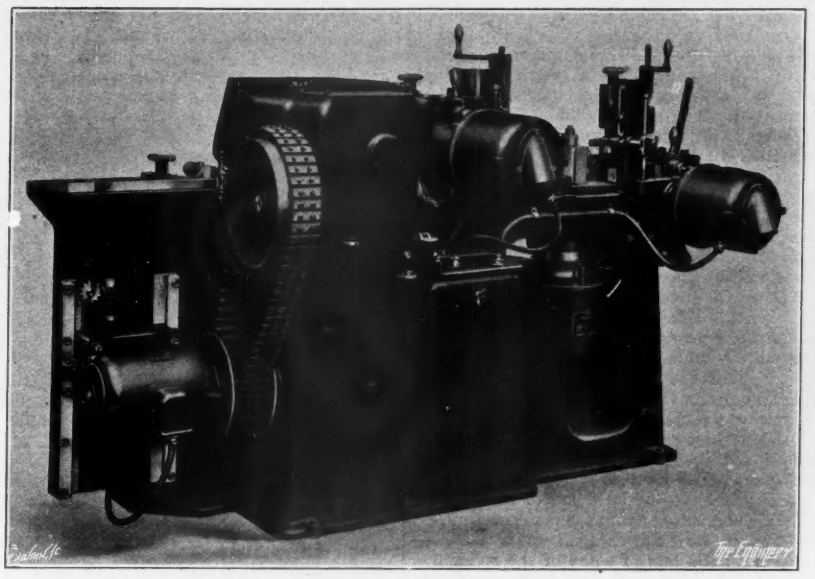


FIG. 5—ELECTRICALLY-DRIVEN PLANER AND MOULDER

FIG. 6—MOTORS IN A BLACKING FACTORY

Crompton-Parkinson motors for drilling five holes simultaneously. The application of B.T.H. "built-in" motors to an Archdale rivet hole driller is shown in Fig. 4, while Fig. 5 shows a high-speed four-sided planer and moulder. The B.T.H. electrical equipment includes a squirrel-cage feed motor and frequency changer which operates four high-frequency "built-in" motors for the spindles. An interesting example of the use of Crompton-Parkinson "Klosd" motors under adverse conditions is shown in Fig. 6, which illustrates five motors in a blacking factory. The motors are housed in a passage outside the main shop and the shafts pass through the wall. An exhaust fan draws off any fumes that may penetrate into the motor chamber. Electrically operated bore-hole Mather and Platt pumps are shown in Fig. 7. The B.T.H. motors are A.C. variable-speed commutator machines rated at 150–110 h.p. at 1050–830 r.p.m.

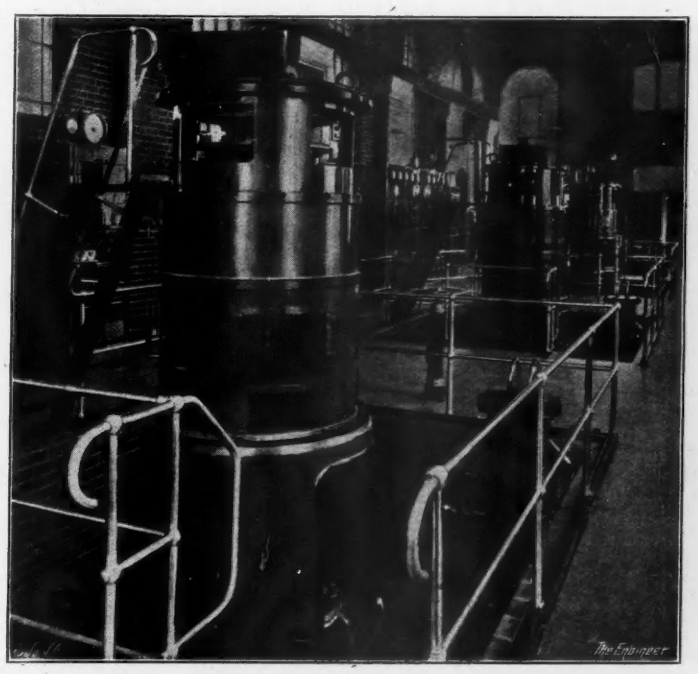


FIG. 7—VARIABLE SPEED A.C. MOTORS DRIVING PUMPS

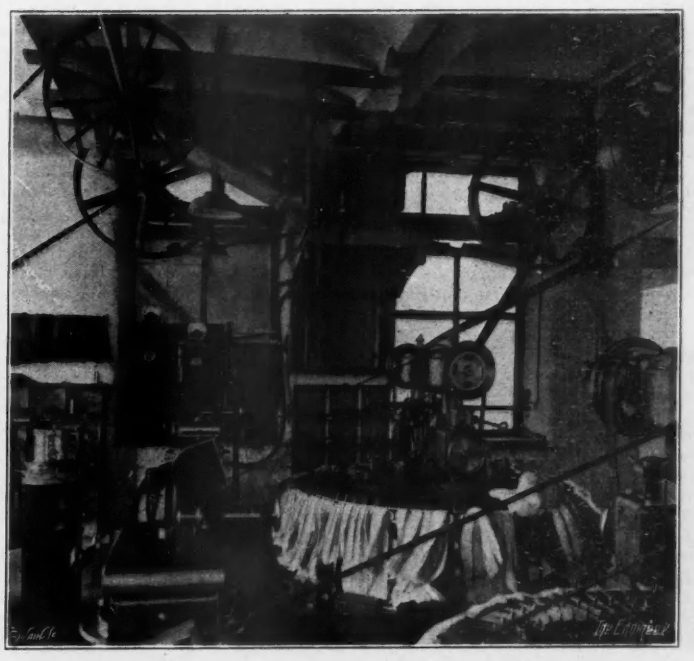


FIG. 8—GROUP DRIVE IN A WOOL-COMBING FACTORY

A.C. variable-speed commutator motors were at one time rarely used in this country, but they are now employed fairly frequently, and they have much to recommend them in certain industries. A good example of modern group driving is shown in Fig. 8, which illustrates a 50 h.p. Crompton-Parkinson auto-synchronous motor operating in a wool combing factory through right and left-hand Texrope drives.

(To be continued.)

British Railways as a National Asset.

No. IV.

(*Concluded from page 164, August 16th*).

HOW THE PUBLIC IS SERVED.

COMING now to a consideration of the achievements of what used to be called the traffic department, but which, as it has little to do with the commercial side, is better and more correctly known as the operating department, we must first deal with a question which is partly civil engineering and partly "operating." We refer to signalling.

Signalling.

It is not unsafe to say that in no sphere of activity have such proportionately great economies been effected as are those obtained by improvements introduced by the signal engineer. Those economies lie mainly in the number of signalmen employed. According to the railway census of March, 1928, there were then 28,200 signalmen; the census for 1934 showed that the number had by then been reduced to 25,032, a drop of 11·23 per cent. That was not an economy obtained by manning the boxes by porter-signalmen, as although there were more men employed in that lower grade in 1934 than in 1928, the total for the former year was only 2132 as compared with 1857 in 1928. The less number of signalmen, accompanied possibly by regrading of some of the remaining men, reduced the wages paid to signalmen from £5,480,000 in 1928 to £4,670,000 in 1933, a drop of 14·78 per cent. It is significant also that comparing 1933 with 1928 there was a saving in traffic expenses of 17·00 per cent., of which 9·34 per cent. came from a reduction in the wages paid to signalmen.

These savings in the number of signalmen and in the wages paid to them have been made possible by (1) concentrating the work at stations, yards, &c., into fewer signal-boxes, and (2) by the provision of automatic signalling which has allowed many of the signal-boxes intermediate between stations to be dispensed with. There would therefore seem to be good ground for the statement in the L.N.E.R. Review of the Company's Business which accompanied the annual report for 1932 that "probably no department of railway working has made such outstanding progress during the last ten years as that of signalling."

Speaking of the economies achieved by signalling, Sir Josiah Stamp said at the L.M.S. meeting on February 27th, 1931, that during 1928 and 1929 fifty-seven schemes had been completed, whereby £12,257 a year, or 47 per cent. on the outlay, was saved. In 1930 further schemes had been authorised, which would yield an economy of £11,500 per annum —the speaker did not intimate what outlay had been entailed—and although it was impossible at that stage to say what the ultimate figure was likely to be, it was hoped to achieve a total of £100,000 a year. No corresponding information was given a year later as to the results in 1931, but by the time of the meeting on February 24th, 1933, the number of schemes carried out had increased to 239, which were producing 31 per cent. on the outlay and by February 23rd, 1934, the schemes numbered 334, and they realised well over 20 per cent.

The direction in which these savings were obtained was indicated by a remark in the L.N.E.R. Review for the year 1930. That paper said that with a view to increasing the factor of safety and to facilitating traffic movements, the policy of steadily equipping the company's lines with the requirements of modern signalling apparatus was being actively pursued. At the end of 1930 the L.N.E.R. had about 800 miles of line track-circuited, and the figure was growing monthly. The protection afforded by track circuit is, in conjunction with the introduction of power-operated points, enabling the company to effect reductions in the number of signal-boxes. On the Southern Railway the then chairman said on March 1st, 1934, that the installation of up-to-date methods of signalling had enabled the company to close more than 200 signal-boxes and to effect a saving of £90,000 a year in the cost of signalling.

It should be noted that most of these economies have been won at the cost of "signal maintenance." wherein the figure for signal maintenance for the years 1929–33 are as given below. To them we have added a comparison between the results in signalmen's wages and in signal maintenance.

Year	1929.	1930.	1931.	1932.	1933.
	£	£	£	£	£
Signal maintenance	1,936,553	1,823,580	1,918,784	1,909,498	1,738,454
Percentage drop below 1929:					
In gross receipts	—	5·58	13·33	20·50	20·50
In wages of signalmen	—	0·59	7·30	11·84	13·78
In maintenance of signalling	—	5·82	0·92	1·40	10·23

The closing of a signal-box means the displacement of material that has been paid for out of capital, and the work is therefore a charge on revenue. There is thus created the anomaly that signal maintenance, instead of falling in line with the decrease in business and as the maintenance of the way and works and of the rolling stock was reduced, has remained almost constant. That is seen in the Railway Returns for 1933, expected having regard to the better type of locomotive. Improved locomotives, lighter loads, and less traffic on the line have, however, expedited the transport. On this point we have the testimony, on February 24th, 1933, of Sir Josiah Stamp, that 67 per cent. of the consignments by the L.M.S.R. were delivered on the day after dispatch, and 93·7 per cent. within forty-eight hours. A year later, these two percentages were 69·4 and 94 respectively.

Not only in the time of transit, but in the reception and delivery of consignments, have improvements been made. Sir Josiah said, on March 1st, 1935:

"The arrangements for handling goods at terminal points have been the subject of various radical experiments which we are confident will effect steady reduction in our operating costs and handling times. This is an important link in the throughout service, and the dual object of quick transit from sender to receiver and the reduction in costs is being achieved."

Most satisfactory results have been attained by what is officially known as "registered transits," but which, because of the labels used, is popularly termed the Green Arrow Service. It originated on the Great Western. Under this plan, a payment of 2s. 6d. per consignment—whether it be a single parcel, a wagon load, or even a full train—ensures delivery by a specified time. To do that the consignment is kept under watch at every stage. The London and North-Eastern copied the idea from the Great Western, and during the first month—June, 1933—it accepted 244 consignments; on March 8th, 1935, Mr. Whitelaw said that more than 10,000 registered transit consignments were passing every month.

Transport Expedited.

A remarkable feature in railway operation is that although the traffic has fallen off so considerably, the method of handling the business offered has greatly improved. The attitude taken by the railways generally was perhaps best indicated by a remark in the L.N.E.R. Review for 1932 to the following effect:—

"Being of opinion that the withdrawal of facilities and the reduction of the efficiency of train services was not the way to meet decreases of general traffic, the L.N.E. directors authorised improvements in train operation, designed to increase the facilities offered in both the passenger and freight departments. . . . An important feature . . . has been the development of high-speed freight trains, fitted throughout with vacuum brakes. Many trains of this description are now run by this company, of which an example is found in the daily express from King's Cross to Glasgow, which, with a load of fifty wagons, completes the journey in 13¼ hours, and is believed to be the fastest freight train in the world."

In our second article of this series we mentioned the fact that in order to avoid delay of the reduced business that has resulted from trade depression, by waiting until a full load for a wagon was available—and thus running the risk of some of the remaining business finding its way on to the roads—the companies dispatched wagons when under-loaded. This fact prompts the observation that, owing to the reduction during the last forty or fifty years in the time taken for the transit of goods by railways, merchants need no longer hold the amount of stock that previously was necessary. For instance, a tailor requires only to keep patterns of cloth by him, and when a customer has made his selection, a telephone message or a telegram will bring the length of material from the mills at Bradford within twenty-four hours.

The depression in trade and the greater scarcity of money have led to merchants and manufacturers reducing the amount of material they purchase at one time, and that has made the size of the consignments, offered to the railway companies for transit, smaller, and there are now more consignments to the ton than there used to be. Incidentally, that increase in the number has led to greater time being required to handle each ton of goods. On that point, Sir Josiah Stamp said, at the L.M.S. meeting on February 23rd, 1934, as to the continual tendency of business to increase the difficulty of handling a given tonnage:—

"In 1933 compared with 1932 there was an increase in the number of consignments per ton of goods traffic of about 3 per cent. Compared with ten years ago, the number of consignments per ton of goods traffic has increased by 37 per cent. To put the matter another way, if the weight per consignment had been the same in 1933 as it was in 1932, we should have had 2,750,000 fewer consignments, and if the weight per consignment had been the same as it was in 1923, 27,500,000 fewer consignments would have been dealt with. In spite of the increase in the number of consignments per ton, however, the average time occupied in handling 100 tons of traffic in 1933 was 128 man-hours, compared with 130 hours in 1932 and with 136 in 1923."

It should be remarked that whilst the details just given are the result of the experience on the L.M.S., the facts as to the increase in the number of consignments per ton are common to all the companies, and possibly also that of the time occupied in handling them.

The less business that has come to the railways of recent years not only led, as said above, and in our second article, to the load per wagon being less, but the number of wagons per train has not increased; the latter improvement might naturally have been

Increased Operating Efficiency.

On the same occasion, the L.N.E.R. chairman said:

"The statistics of operating efficiency for 1934 show, on the whole, a favourable comparison with 1933. The average freight train load, at 131·74 tons, was up by 2·3 per cent., while the average starting-point wagon load was better for general merchandise, minerals, and coal class traffic, the total of 7·91 tons showing an improvement of 2·33 per cent. over the 1933 figure.

"As was to be expected, in view of the increased traffic in 1934 over 1933, freight train-miles per train-hour showed a slight decrease, but the figure of 9·22 miles per train-hour for 1934 was only 0·86 per cent. below the figure for 1933. Passenger train-miles per train-hour showed an increase of 0·71 per cent. over 1933. This is the highest figure yet recorded, a progressive increase having taken place since amalgamation."

We find here a welcome opportunity to quote something of the Great Western experience. On February 27th, 1935, Sir Robert Horne said:

"The low ratio of expenditure to receipts is, however, very satisfactory, and indicates that we are now reaping the benefit of the sums which we have disbursed during the past few years in improving our facilities for the handling of traffic. Perhaps the best indication is to be found in the fact that while freight train-miles run in 1934 increased by over 4 per cent. and the passenger train-miles by nearly 3 per cent., the increase in operating expenditure was only 1½ per cent. There was, in fact, a marked advance in our general operating efficiency; the average mileage run daily per engine was higher than in any previous year, while the consumption of coal per engine-mile was the lowest on record."

It was significant, however, to hear Sir Robert later remark that the increase of £90,000 in passenger receipts was earned at the expense of an additional 1,000,000 train-miles, and that he was afraid that the cost of that additional running and other incidental expenses fully offset the increase in the gross receipts and that a much more substantial augmentation in the number of passengers was necessary before any material benefit could be obtained by the company.

Government Assistance for New Works.

Coming now, in concluding this series of articles, to consideration of railway administration and railway policy generally, we may refer to Sir Robert Horne's remark, quoted above, concerning the reaping of the benefit of the sums disbursed during the past few years in improving the facilities for the handling of traffic.

A good many of the new works referred to by Sir Robert, as well as many, equally beneficial, on other railways, were the result of the remission, under the Finance Act of 1929, of the passenger duty, instituted in 1832, that was paid on all first-class fares. The conditions were best explained in the Great Western report for 1929, when it was said that the remission was "conditionally on the capital equivalent of this relief from taxation being used to stimulate the development and modernisation of railway transport." It was laid down that all such works were to be actually begun by the end of March, 1930.

Further new work was undertaken under the Development (Loan Guarantees and Grants) Act, 1929, which was passed in order to relieve unemployment. Under that Act the railways and public authorities were encouraged to carry out works by the Government guaranteeing for fifteen years the interest on capital expenditure on approved works.

Little is known as to how the companies spent the money saved by the remission of the passenger duty. The Southern report for 1929 said that that company would have to spend over £2,000,000, and that it was proposed to carry the electrification of the Brighton line on from Coulsdon to Brighton and Worthing. The L.M.S. report for the same year recorded that that company had made schemes that would involve an expenditure of £2,400,000, and the

L.N.E. Railway gave its sum as £1,500,000. The latter company's report for 1932 recorded that £1,073,419 had been spent.

All the companies, no doubt with a commendable desire to assist in relieving unemployment, prepared ambitious schemes under the Development Act. The Great Western's programme, as indicated in the "Further Capital Expenditure" table in the report for 1930, was for £6,432,000. Sixteen works were therein named. They included £2,000,000 for modernisation of the company's docks in South Wales; over £1,000,000 for the enlargement of Bristol Station, and for widenings outside that station; improvements at Paddington and Cardiff; widenings on both sides of and through Taunton; the deviation of the lines at Westbury and Frome; and a widening on the south side of Birmingham. The only works undertaken under this Act by the Southern was the second stage of the Southampton Docks extension, estimated at a capital cost of £3,000,000, and the new graving dock there at an estimated cost of £1,850,000. The L.M.S., by the end of 1929, had approved schemes to the amount of £1,800,000, and consideration was being given to others of the value of £3,250,000. The London and North-Eastern gave no details until the report for 1930, and then said that £2,146,639 had been sanctioned, and a further expenditure of £484,900 was contemplated. By 1931 the intended expenditure was £3,508,185.

Apparently, owing probably to the business situation getting worse, all the companies, except the Southern, modified their intended programmes. The L.M.S.R. report for 1930 indicated that, instead of spending the £5,000,000 mentioned in the report for 1929, the list of schemes had been revised and it thus totalled £1,800,000. Then, the L.N.E.R. report for 1934 said that the opening of the Parkeston Quay Extension marked the completion of all the works and that the total amount expended up to the end of that year was £2,671,526. The Great Western report for 1933 suggested that that company was spending only about £3,000,000 instead of the contemplated nearly £6,500,000.

From the table given in the G.W. report for 1930 it may be seen that, as said above, sixteen schemes were contemplated; but Sir Robert Horne, on February 27th, 1935, spoke of forty schemes in all. He added, on the subject in general: "As the schemes were carried out during a time of acute depression, we were able to assist very greatly in the relief of unemployment, and many of the traders on our system benefited through the contracts which we were able to place with them. The works were carried out with much less dislocation of traffic than would have been the case under more normal conditions."

It should be noted that the Act of 1929 was limited to a period of three years and the power to give assistance expired on August 31st, 1932. A matter of more importance is that in no case was a grant made; the only assistance was in the way of guaranteeing interest on the capital expenditure.

High-speed Light Passenger Units.

A source of economy is to be found in the provision of high-speed light passenger units between business centres. The economy lies in the fact that the load is light and the fuel consumption per mile consequently low, and that the driver does not need a fireman. Furthermore, the guard can act as a buffet attendant should refreshments be served on the train. A successful example of this is found in the three cars running between Birmingham and Cardiff, G.W.R. They call only at Stratford-on-Avon, Cheltenham, Gloucester, and Newport, and they are used principally by through passengers who are limited in number. They make the journey of 118 miles in 2 hours 23 minutes, or an average speed of 50 m.p.h.

A point we would make in this connection is that high-speed trains bring difficulties in their operation, in that "paths" have to be found for them in order that they may not lose their reputation by being delayed by other trains. To secure punctuality for the high-speed trains the slower have to be shunted or crossed on to and travel over another line. Such crossing means a little delay in the running of the slower train and a "path" has to be made for it, and thus some of the profit accruing to the high-speed train is lessened. It must be remembered, too, that the principal units used in the cost of train operation are the train-mile and the engine-mile. As a train-mile and an engine-mile have the same value for an oil-electric train and for a rail motor train as for a heavy important express there was a particular significance in the remark by Mr. Whitelaw at the L.N.E. meeting on March 4th, 1932, that out of the 65 million train-miles run during the previous year, 2¼ million miles were run by rail motors and other similar small units.

Road Transport Competition.

The opinion has very widely prevailed that British railways have only themselves to blame for the hold road transport interests secured in the carriage of goods traffic. Our own views as to how that came about were once more presented in a leader, "The Regeneration of British Railways," in THE ENGINEER of May 25th, 1934. Therein, after saying that when the Board of Trade was the Governmental department responsible for the railways it never interfered with their administration, we observed: "With the advent of the Ministry of Transport in 1919, however, the pendulum swung right over, and the companies were curbed, crippled, and discouraged. No better example of that can be found than the attitude taken when in 1922—long before there was any road-rail problem—the London and North-Western and the Midland companies sought road powers. Traders at first opposed the scheme, but their support was won, and when the Whitsuntide recess was over an easy passage for the Bill seemed assured. But at the last moment the Ministry of Transport asked for conditions that the companies could not accept and they withdrew the Bill. That had a most unfortunate effect, and was the origin of road competition and the consequent great losses to the railways. The companies had their hands full then with the problems that grouping brought in its train and by the time they could turn their attention seriously to stopping the leakage of traffic to the roads the mischief had been done."

The first road transport powers given to the railways were secured by separate Acts to each railway in 1928, but they effected passenger traffic only and, generally, were wisely exercised by the purchase of existing carrying companies or of an interest therein. The L.N.E.R. Review for 1930 said that the company had, in some cases, to pay heavily for participation in the business, but there was no doubt that the policy adopted had proved much more successful than would have been the case if the company had taken the alternative of establishing themselves on the road in competition with existing road transport companies. In 1931 a return of approximately 7 per cent. on the capital invested in road passenger business was reported, besides a saving of £71,000 a year by the withdrawal of passenger trains in districts where public convenience could be provided by road services. In 1932 the return was 6·72 per cent., and in 1933, on an investment of £2,471,566, it was 7·11 per cent. For 1934 the profit was 7·97 per cent. and the savings brought about by the withdrawal of passenger train services on branch lines amounted to approximately £93,000.

The Road and Rail Traffic Act, 1933, is too recent to call for comment, either favourable or unfavourable, here. At all events it was hardly mentioned in any of the reports for 1934 nor at the annual meetings that followed in the spring of the present year.

Amount of Stores and Materials on Hand.

A legacy that the railways, on amalgamation at the end of 1922, inherited was the enormous value of the stock of stores and materials that the various hitherto independent companies had on hand. The Railway Returns for that year put the value at £23½ millions—it was only £14 millions in 1913—but, despite the grouping of the companies, it was as high as £22¾ millions in 1928 and remained still high in 1929 and 1930, being £21 millions and £22 millions respectively.

This is a very important matter. The financial returns in the annual reports close with a general balance sheet of liabilities and assets. According to the Railway Returns for 1933, the assets of all the British railways were placed at nearly £174 millions. Of this sum, capital subscribed but not expended, cash in hand and at bankers and the value of investments in Government securities accounted for £120 millions. The remaining £54 millions were spread over nine items—two of which were less than £1 million—and the highest of these nine items was £15¼ millions for stores.

The question of the large amount of money that lay invested—much of it idle—in this way was one that received attention at the hands of the research service of the L.M.S. Railway. Sir Josiah Stamp said on this subject, on February 26th, 1932, that the value at the end of 1931 was £1,570,000 less than in 1930 and £2,800,000, or 27 per cent., less than in 1927. Half of that sum, he said, was due to improved organisation in storekeeping, which, incidentally, had reduced the number of items by 35 per cent. We regret that no other company has thrown any light on this important matter, but the following table shows that the L.M.S. is not alone in securing a reduction in the value of the stock on hand.

Year	1929.	1930.	1931.	1932.	1933.
	£	£	£	£	£
L.M.S.	8,620,172	9,161,386	7,594,318	6,436,784	6,117,354
L.N.E.	6,668,653	6,519,939	5,696,382	5,006,440	4,507,543
G.W.	3,400,399	3,768,847	3,514,548	3,147,188	2,693,436
Southern	2,091,442	2,382,119	2,255,009	2,077,194	1,768,731
All British railways	21,037,469	22,044,967	19,249,022	16,851,491	15,253,795

A minor purpose that this table will serve is to show what good customers the railway companies are.

Electrification.

Although the general electrification of railways is occasionally advocated, that never has been done by anyone engaged in railway operation. The electrification of railways in suburban areas is, however, a totally different and much more favourable proposition. What has been done on the Southern Railway appeals to those who have a leaning towards the conversion of steam-worked railways to electric traction. For instance, Mr. Holland-Martin, at that company's meeting on February 28th, 1935, said that the number of passengers in 1934 was over 13½ millions more than in 1933, and that of these an increase of 11 millions came from the electrified lines, and that the passengers on the latter provided an increase of £302,000 in the receipts.

That the Southern example cannot readily be followed by the other companies was revealed by the comments in the L.N.E.R. Review of the Company's Business in 1934, as to the electrification of the suburban area of the former Great Eastern Railway. These read:—"Various schemes for electrification had been put forward, . . . but none of them was found satisfactory. . . . The Board had several fresh schemes prepared, but the initial and principal difficulty was that the existing lines between Liverpool-street and Stratford were already fully loaded and were carrying the heaviest suburban service, steam or electric, to be found anywhere in the world. No intensification of the service could be obtained to justify electrification, except by a further widening of the lines between Liverpool-street and Stratford and a rearrangement of the slow and fast lines by means of a flying junction. These works were estimated to cost £3,000,000, apart altogether from expenditure on electrification proper. Apart from this the traffic to be handled was of a peculiar character—very heavy during the rush hours, morning and evening, relatively light at other times. The total expenditure involved would amount to £7,000,000, and no adequate return could be expected on the outlay. . . . The possibility of a tube scheme was also considered, but here again the expenditure involved was heavy and the net return negligible."

"The Board came to the conclusion that in the absence of a pool of competing interests and of substantial Government assistance, electrification of the Great Eastern suburban lines could not be other than a losing proposition which the financial circumstances of the company did not allow them to undertake."

The electrification of railways in the London suburban area is no longer a matter for any individual company to concern itself over in view of the establishment of the London Passenger Transport Board. As Mr. Holland-Martin also said on the occasion just named, the electrified lines are mainly in the London suburban area, and any increase in net revenue from passenger traffic was now divisable with the London Passenger Transport Board and the other main line companies in accordance with the London Passenger Transport Act, 1933.

The announcement of the Chancellor of the Exchequer, that the Government would guarantee the payment of interest on a capital expenditure of £40,000,000, has now solved the financial difficulty of the Great Eastern Electrification. It provides also for some work on the neighbouring Great Northern section and on the Greenford line of the Great Western. A considerable amount of new construction of the London Passenger Transport Board is included.

The Railway Rates Tribunal's Opinion.

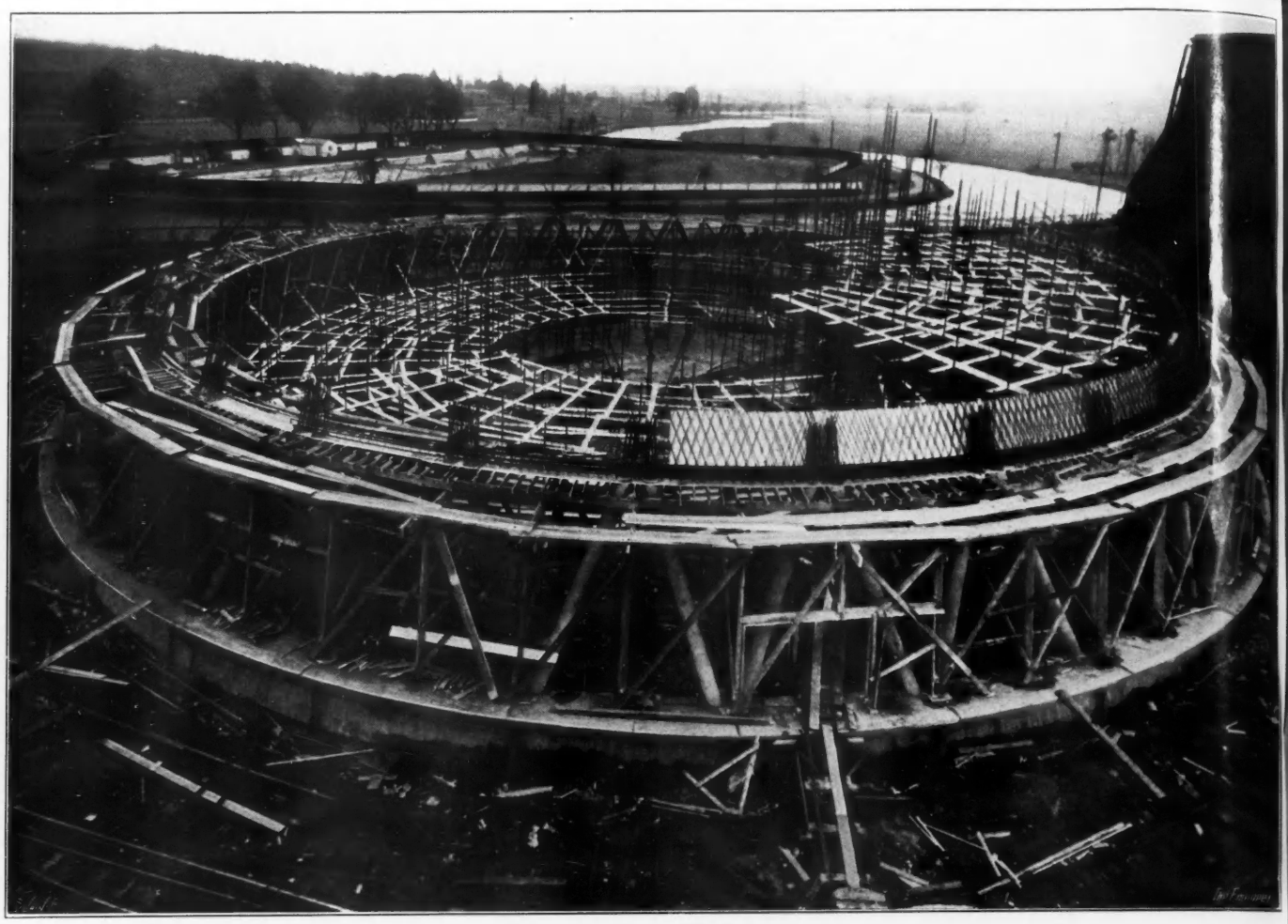
The general trend of these articles has been to show that great economies have been effected on the British railways, especially by their engineers, during the last five or six years. That that has not been done by reducing the high standard of maintenance or the efficiency of operation, may be seen in a fact with which we will conclude our comments.

Under Section 58 of the Railways Act, 1921, the railway companies were, in a sense, guaranteed a net revenue equal to that of the year 1913, and traders, similarly, were assured that if the revenue rose, they were to share in the extra profits. The traders were further assured that in securing the greater revenue the companies had maintained "efficient and economical working and management." That was to be secured by an annual review by the Railway Rates Tribunal. The conditions prevailing during the year 1934 were duly reviewed by the Tribunal, whose judgment of June 29th, 1935, said on this point that it was satisfied that the deficiency in the net revenue—below the amount anticipated by the Act of 1921—of each of the amalgamated companies, was due to the continued depression of trade, the reduced spending power of the population, and intense competition of other means of transport—not to lack of efficiency or economy in the management.

A LARGE new factory is being equipped at Bromborough Port, Cheshire, for the manufacture of commercial chemical solvents used in a wide range of industrial processes. Orders for plant and machinery of the latest type to a total value of £250,000 have already been placed in Great Britain, and when production is begun in October employment will be provided for a large number of men.

CONSTRUCTION OF A REINFORCED CONCRETE COOLI T

L. G. MOUCHEL AND PARTNERS, LTD., CIVIL ENGINEER SIR R



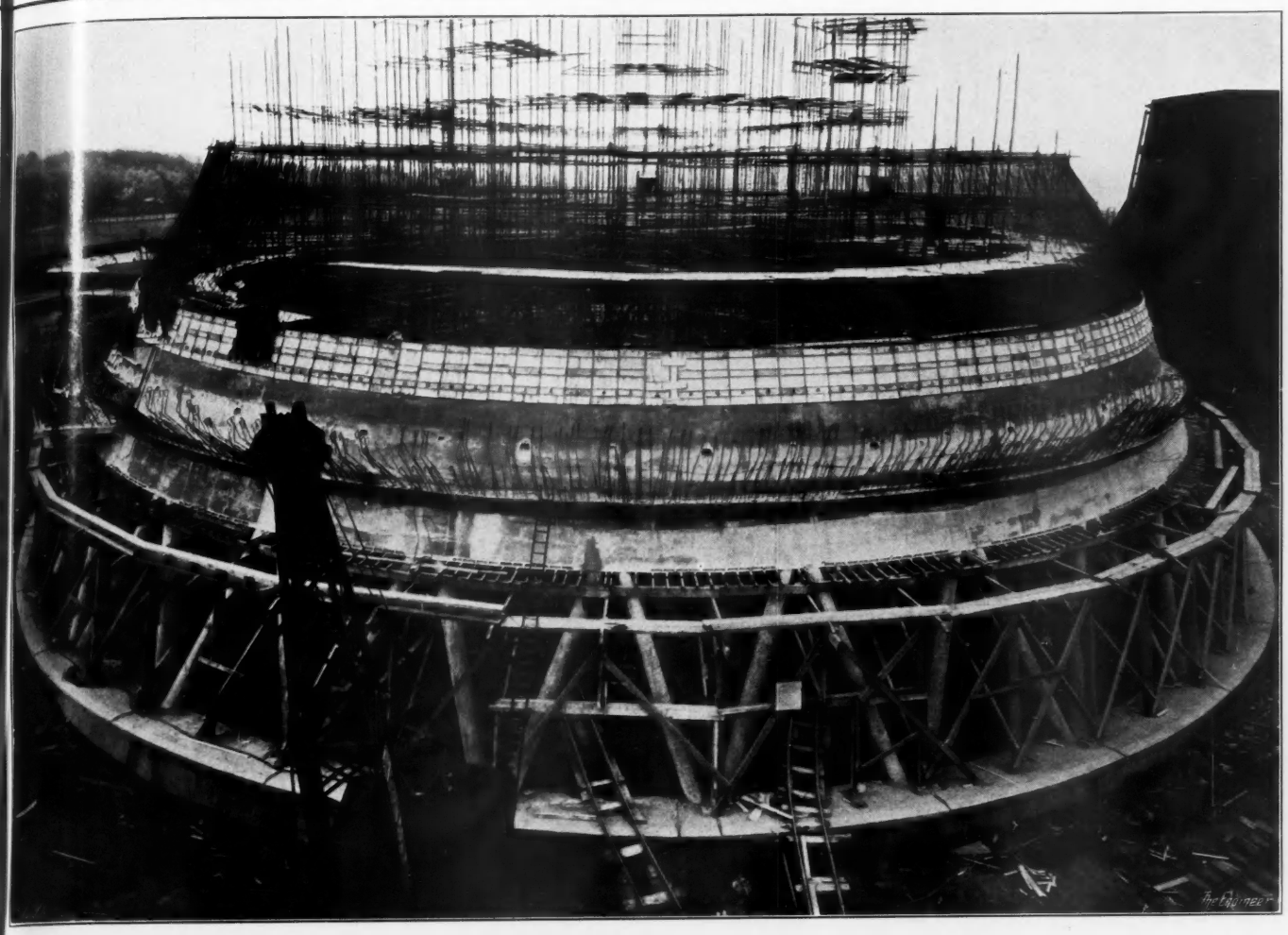
MARCH 30TH, 1935

MAY 25TH

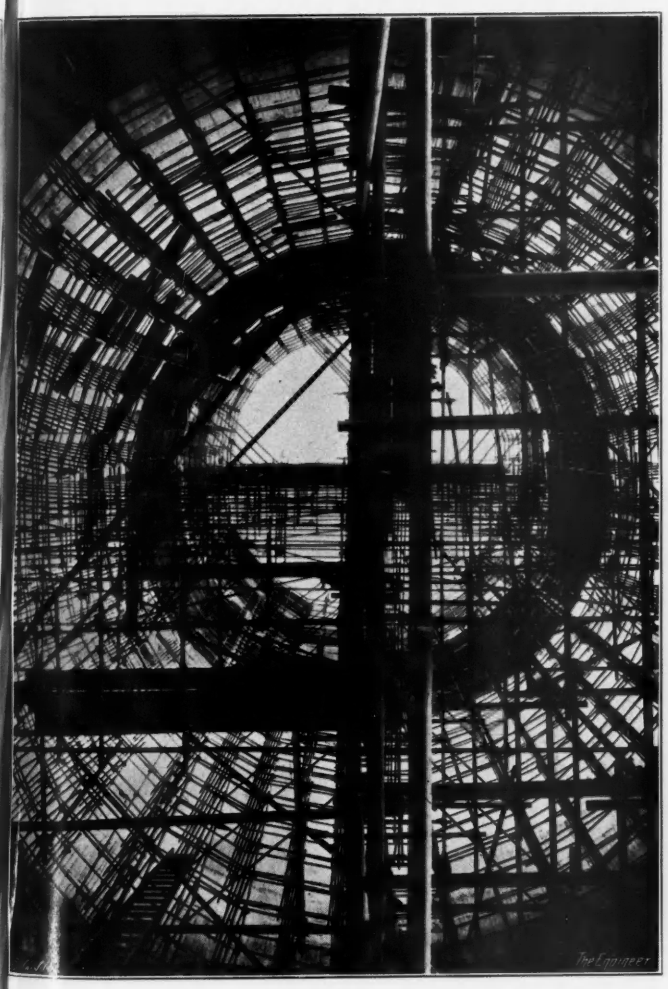
JUNE 22ND

TOWER AT HARDINGSTONE STATION, NORTHAMPTON

SIR ROBERT McALPINE AND SONS, LTD., CONTRACTORS



APRIL 27TH



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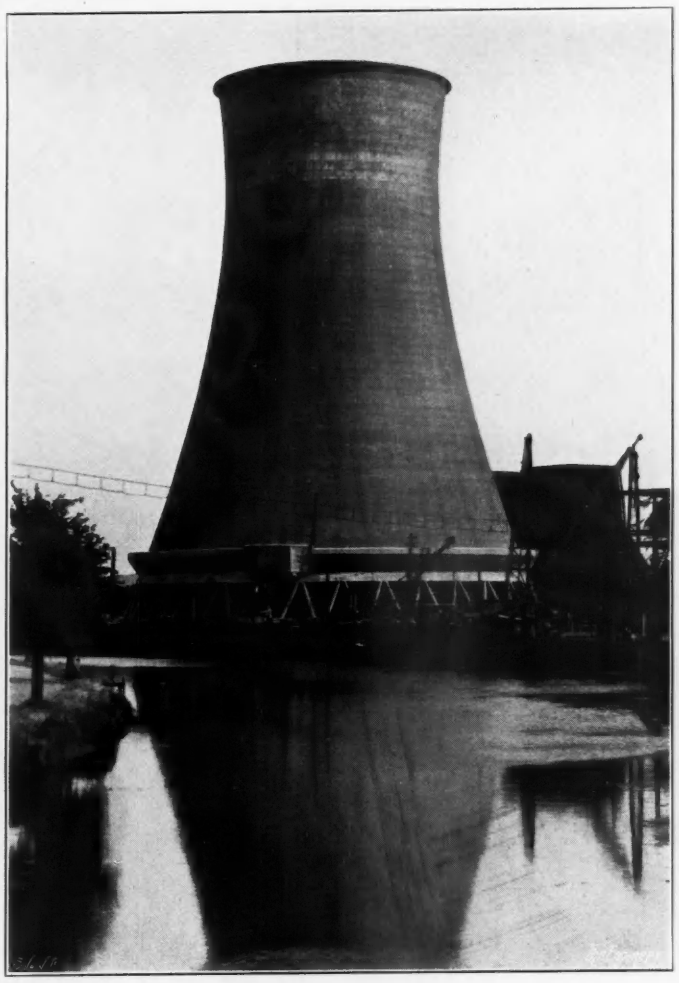


JULY 3RD, 1935

INTERIOR OF BANANA SHED AT WEST INDIA DOCKS, LONDON

The Banana-Carrying Steamer "Jamaica Producer."

No. II.

(*Concluded from page 167, August 16th.*)

IN our last article we described the banana-carrying steamer "Jamaica Producer" and her propelling and refrigerating equipment, making special mention of the subdivision of the holds and 'tween deck spaces into bins, in which the fruit is transported in an atmosphere of cooled air.

Of equal interest to our readers is the method adopted for discharging the cargo, and the loading of the fruit into vans for road or rail transport. From the plantations in Jamaica the bunches of bananas are brought down to the coast in their green, unripe state, and are transferred to the ship by hand either from lighters or from the quay at the port of Kingston. A typical cargo may consist of up to 120,000 bunches of bananas, each bunch consisting of eight or nine "hands," amounting in all to 120 or 130 single bananas or "fingers," so that a total of thirteen to fifteen million bananas may be carried. Under normal service conditions the voyage from Kingston to London may take about thirteen days. Immediately loading operations have been completed and the hatches closed, the cargo is cooled down to about 52 deg. Fah., and is carried at that temperature. On its arrival in London the object aimed at is to unload and to distribute the fruit as quickly as possible while it remains in the "prime dead green state" desired by the wholesale dealers. Before retail sale the fruit is ripened off in suitably designed stores.

The ships of the fleet of which the "Jamaica Producer" forms one are four in number, and they and the bananas they carry are the property of the Jamaica Banana Producers' Association. The sale and distribution of the bananas are entrusted to the Jamaica Producers' Marketing Company, Ltd., of 19, Henrietta-street, London, W.C.2. This company now markets for the Association one cargo of bananas each week throughout the year, the cargoes being delivered at the Port of London Authority's West India Dock. In order to facilitate the quick and economical discharge of the cargoes, and the loading of the bananas into road vans and lorries and insulated railway wagons, the Port of London Authority has laid down a special installation of automatic conveying machinery at A Shed, West India Export Docks. A general view of the interior of the shed is reproduced above. This engraving shows the long line of insulated railway wagons and the road transport vehicles, all of which are served by conveyor bands. The structural features of the shed and quay and the arrangement of the loading platforms and conveyor bands are shown in Figs. 10 and 11. The whole of the conveying installation was designed and supplied by Rownson, Drew and Clydesdale, Ltd., of 225, Upper Thames-street, London, E.C.4. It comprises four Donald pattern patented canvas, sling type, portable elevator conveyors, which unload the fruit from the steamer and deliver it to four belt conveyors on the quayside.

As will be inferred from Fig. 14, the elevator conveyors are self-contained units built within a lattice girder, and provided with 3 b.h.p. electric motors, starters, and gearing for driving the chain belt, which is fitted with a series of canvas loops in which the bunches of bananas are carried. Before the work of unloading the ship is begun, as shown in Figs. 11 and 14, the hanging bight in the ship's hold is lowered to its full depth, so that fruit can be loaded at any 'tween deck and at the hold level simultaneously. The designed maximum capacity of each elevator-conveyor is 2600 bunches of bananas per hour, and automatic counters are provided to keep a tally. Each of the machines weighs about 4 tons. They are lifted aboard by the ship's derricks or the harbour-side cranes. In order to protect the fruit from the weather, both the deck and the discharging conveyors on the quay are furnished with covered awnings, as shown in Fig. 12. On the quayside the hanging bight is furnished with a padded discharge table, so contrived that the bunches of fruit are

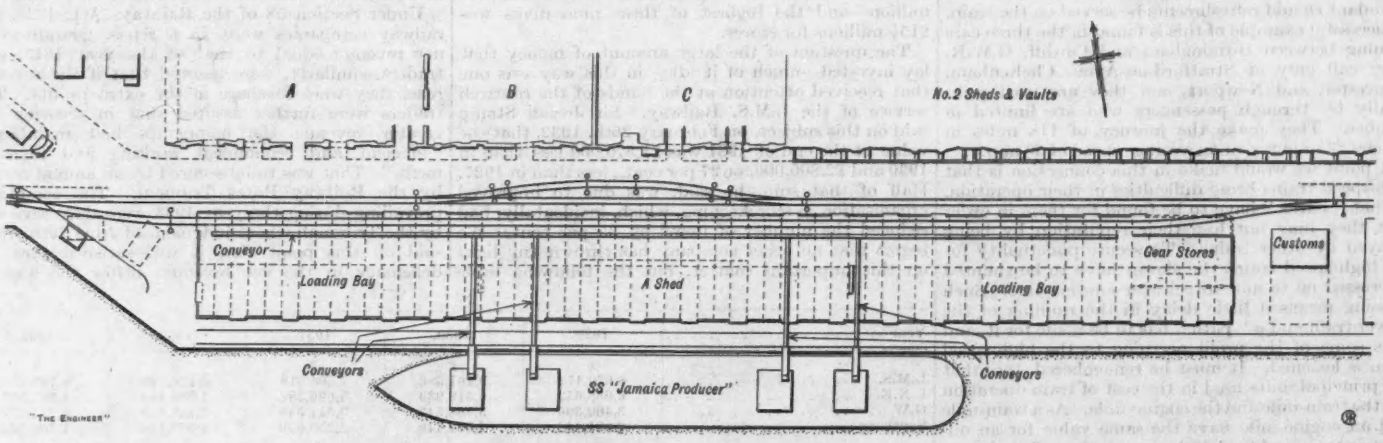


FIG. 10—ARRANGEMENT OF LOADING SHEDS AND CONVEYORS

delivered without bruising or damage on to the conveyor bands.

The drawing reproduced in Fig. 10 shows the general lay-out of the conveyors in the shed, all of which are portable. Some idea of their actual appearance will be obtained from the interior view. The cross conveyors from the unloading elevator conveyors, already mentioned, have belts 36in. wide, and one of them is shown on the foreground of the interior view. Each conveyor has its own electric motors and driving gear, and power is taken from plugs arranged overhead and coupled by a flexible lead. Each conveyor has a novel form of check counter—Fig. 13—consisting of a photo-electric cell operating on the beam system. As each bunch of fruit passes the beam is broken and a switch operated, which adds one to the record kept by the counter mechanism.

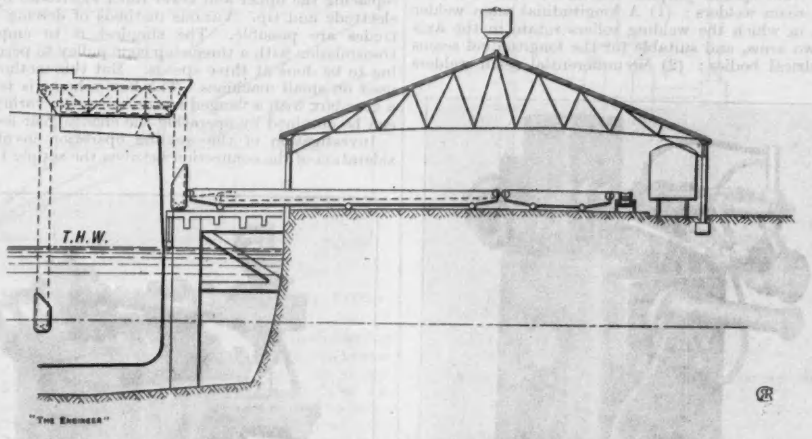


FIG. 11—SECTIONAL ELEVATION OF LOADING SHED

The cross conveyors are each 60ft. in length and deliver the fruit by means of short 18ft. conveyors to the main distributing conveyors, which have belts 20in. wide and run for a total length of 650ft. along the wagon loading bank. The motion of these longitudinal belts is reversible, which facilitates the loading into any particular truck or wagon on the siding. Rail accommodation within the shed is provided for about thirty-two wagons. There are four longitudinal conveyor belts. The two at each end are each 90ft. in length and the centre system is made up of a series of 30ft. long conveyors, all of which are equipped with separate electric motors and flexible power leads. Between these various longitudinal conveyors there are small belt conveyors, each about 12in. in length, which serve the purpose of gently transferring the travelling bunches of fruit from one belt to the other with the least possible damage to the fruit. In addition to the provisions made for loading the railway wagons there are short 18ft. portable conveyors, which can either be used to deliver the fruit to the wagon loading system or be so arranged that road vehicles can be loaded from the 60ft. long, 36in. wide cross conveyors.

The total number of belt conveyors in the system is twenty-eight and their aggregate length is about 1050ft. At all transfer points great care is taken to prevent damage to the fruit, and sponge rubber pads, sprung belt buffers and other safety devices are used, special attendants being placed at these points to see that the fruit is handled carefully. As a rule the ship comes up from Gravesend overnight and arrives at the quay during the early morning hours. The ship breaks bulk about 8 a.m. and unloading is completed in a very few hours, the discharge of citrous fruit in cases proceeding by means of the ship's derricks and the quayside cranes at the same time as the banana cargo is being transferred to shore on the conveyors. As will be seen from Fig. 14, the portable rails forming the banana bins within the ship can be removed, so that free access around the elevator may be given. The fruit is lifted by hand from the bins and transferred to the canvas loops in the elevator belt.

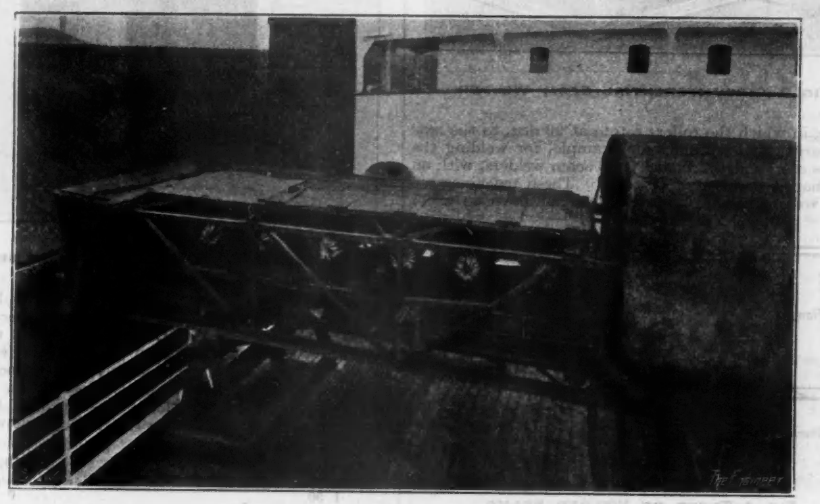


FIG. 12—ELEVATOR-CONVEYOR ON DECK DISCHARGING TO SHED CONVEYOR

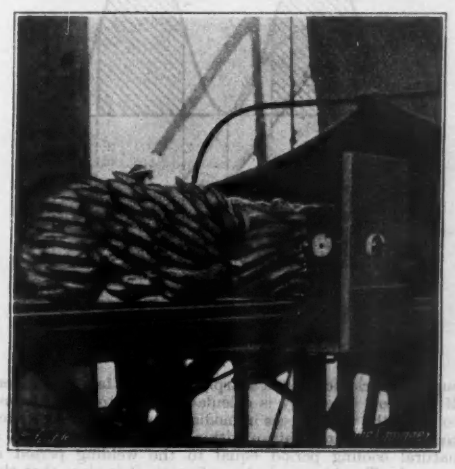


FIG. 13—ELECTRIC RAY COUNTER

FIG. 14—ELEVATOR-CONVEYOR IN SHIP'S HOLD

We desire to express our thanks to the Port of London Authority, Kaye, Son and Co., Ltd., and the Jamaica Producers' Marketing Company, Ltd., for the facilities afforded us in connection with the preparation of this article.

The Iron and Steel Institute.

THE Autumn Meeting of the Iron and Steel Institute will be held in Manchester from Monday, September 16th, to Thursday, September 19th, 1935. The general meeting will be held on Tuesday morning at 9.30 a.m. in the Grand Hall of the Manchester College of Technology. After a welcome by the Lord Mayor of Manchester, the President and Chairman and members of the Reception Committee, the following papers will be presented for discussion:—"The Sixth Report on the Heterogeneity of Steel Ingots," being a report by a Joint Committee of the Iron and Steel Institute and the British Iron and Steel Federation to the Iron and Steel Industrial Research Council; and "Some Aspects of the Fatigue Properties of Patented Steel Wires, II: Note on the Effect of Low-temperature Heat Treatment," by Messrs. E. T. Gill and R. Goodacre. After luncheon at the Midland Hotel, Manchester, the following works' visits have been arranged:—Metropolitan Vickers Electrical Company, Ltd., Trafford Park, Manchester; Mather and Platt, Ltd., Park Works, Manchester; Taylor Brothers and Co., Ltd., Trafford Park, Manchester; Renold and Coventry Chain Company, Ltd., Renold Works, Didsbury, Manchester; Rylands Brothers, Ltd., Warrington.

A civic reception will be given by the Lord Mayor and Corporation of the City of Manchester in the Town Hall at 8 p.m. for 8.30 p.m.

On Wednesday the delegates will meet in the Students' Common Room of the Manchester College of Technology, at 9 a.m., when the following papers will be presented for discussion:—"The Use of the Hele-Shaw Apparatus in the Investigation of the Flow of Metals," by Mr. A. M. Herbert and Professor F. C. Thompson; "Waste-Heat Boilers in Open-Hearth Practice: Second Report of the Open-Hearth Committee, being a Committee of the Iron and Steel Industrial Research Council"; "Investigation of the Behaviour of Metals under Deformation at High Temperature: Part I, Structural Changes in Mild Steel and Commercial Iron during Creep," by Dr. C. H. M. Jenkins and Mr. G. A. Mellor. At 11.45 a.m. the members will embark at Salford Docks on vessels provided by the Manchester Ship Canal Company, for a visit to the Irlam works of the Lancashire Steel Corporation, Ltd., where luncheon will be provided by invitation of the Lancashire Steel Corporation. A banquet and dance will be held in the evening at the Midland Hotel at 7.30 p.m.

On Thursday there will be an excursion to works on the Cumberland coast and visit to the Lake District, during which the members will have an opportunity of inspecting the Moss Bay and Millom works of the United Steel Companies, Ltd., and the Millom and Askam Hematite Iron Company, Ltd., respectively. Luncheon will be served at the Keswick Hotel, Keswick. A special train, on which dinner will be served, will leave Ulverston, arriving at Manchester at 9.40 p.m.

Special arrangements will be made for the ladies attending the meeting.

Other than the official visits, members are invited to inspect the works of the following firms:—Churchill Machine Tool Company, Ltd., Broadheath, Altrincham; Craven Brothers (M/C), Ltd., Vauxhall Works, Reddish, Stockport; Ferranti Ltd., Hollinwood, Manchester; National Gas and Oil Engine Company, Ltd., Ashton-under-Lyne; George Richards and Co., Ltd., Broadheath, Altrincham; Henry Simon, Ltd., Bird Hall-lane, Cheadle Heath, Stockport; West's Gas Improvement Company, Ltd., Albion Ironworks, Miles Platting, Manchester.

The following papers will not be presented at the meeting, but correspondence upon them is invited:—"The Piobert Effect in Iron and Soft Steel," by Dr. E. W. Fell; "The Penetration of Molten White Metals into Stressed Steels," by Mr. W. E. Goodrich; "The Properties of Some Low-Nickel Steels Containing Manganese," by Dr. R. H. Greaves; "Subcutaneous Effects during the Scaling of Steel," by Mr. R. Griffiths; "Examination of the Surface of Tin-plate by an Optical Method," by Messrs. W. E. Hoare and B. Chalmers; "Behaviour of Mild Steel under Prolonged Stress at 300 deg. Cent.: Part II, Experiments on Concentrated Stress in Notched and Drilled Specimens," by Dr. C. H. M. Jenkins; "The Distribution of Phosphorus between Metal and Slag in the Basic Process of Steel Manufacture," by Professor Dr. E. Maurer and Mr. W. Bischof; and "The Morphology of Inclusions in Siderurgical Products," by Professor A. M. Portevin and Mr. R. Castro.

ACCORDING to Colonel Mount's annual report on the railway accidents of 1934, there were, during that year, 29 passengers killed and 38 injured by falling out of carriages during the running of trains. The first-named figure compared with 23 fatal cases in 1933 and with an average of 27 a year for the five years 1925–1929, and with an average of 26 a year for 1920–1924. The report observes that the liability to this class of accident, fatal and non-fatal, in 1934 was 1 in every 24 million passenger journeys. Many of the casualties occurred through doors becoming unfastened owing to interference on the part of passengers, and, in the opinion of Colonel Mount, there was no justification to warrant pressure upon railway companies to adopt any automatic or other door control device.

Electric Seam Welding Machines.

CURRENT for seam welding is derived from a single-phase transformer with its low-voltage secondary winding connected to two rollers, which serve as electrodes. The electrical energy is transformed into heat according to Joule's law, $Q = I^2 r t$, where I is the current passing through the resistance r. The rollers conduct the current to the weld, which constitutes the highest point of resistance; form part of the leverage system, which provides the welding pressure, and feed the work forward. For satisfactory results, the welding pressure, current, and feed must be suited to the work pieces to be formed. A complete seam welder and details of the parts are shown

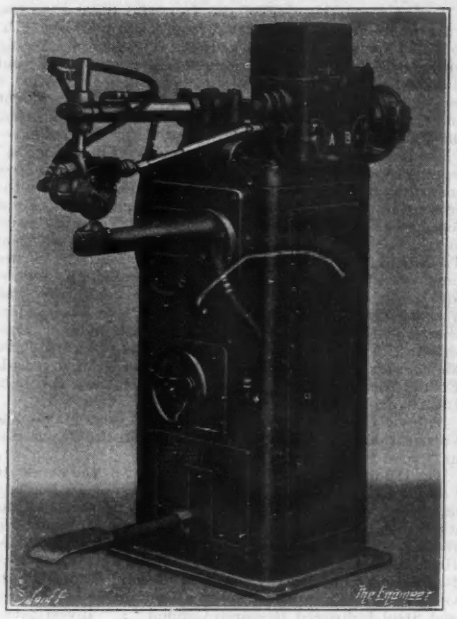


FIG. 1—LONGITUDINAL SEAM WELDER

in Figs. 1 and 2 respectively. Usually the welding pressure is regulated by a spring, the welding current by transformer tappings, and the feed by the roller-driving mechanism.

Seam welders are used in all the sheet metal trades for the welding of overlapped and flanged seams (Fig. 4). When increased thickness due to overlapping is undesirable, and in the case of light-gauge material, change in the cross section can be avoided by means of an imitated butt weld on which a very small overlap is used, equal to the thickness of the metal, the edges then being completely suppressed by the electrode pressure. Another method indicated in Fig. 4 is to bevel the edges before welding, or to use a wire insert. During the welding process the wire is pressed into the space between the work

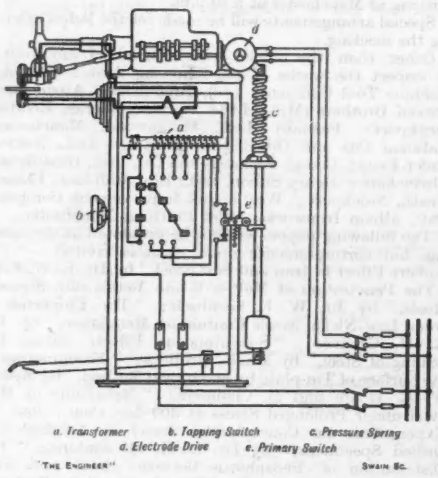


FIG. 2—ARRANGEMENT OF PARTS

pieces, and binds on both sides. The welding ridge formed is subsequently ground off. Naturally, in this case, the weld is not carried completely through the metal. Another application of the system is the welding of thin-walled tubes. Similar and dissimilar metals can be welded.

The primary requirement for a perfect leakproof seam is cleanliness of the surfaces, and if double-pickled sheet steel materials are not employed, it is essential to at least grind off or pickle the welding edges. While it is impossible to weld material of unequal thickness, in the case of ordinary sheet steel and stainless steel, seam welding may be carried out economically up to a total added thickness of approximately $\frac{1}{8}$in., and with brass, German silver, nickel, and aluminium up to about $\frac{1}{4}$in. Proof of the strength and leakage-proof properties of welded longitudinal and circumferential seams has been provided by the production of containers which, when tested under a pressure of 380 lb. per square inch, failed without splitting the welds.

Apart from special purpose machines, there are four kinds of seam welders: (1) A longitudinal seam welder (Fig. 1), in which the welding rollers rotate in the axis of the two arms, and suitable for the longitudinal seams of cylindrical bodies; (2) circumferential seam welders

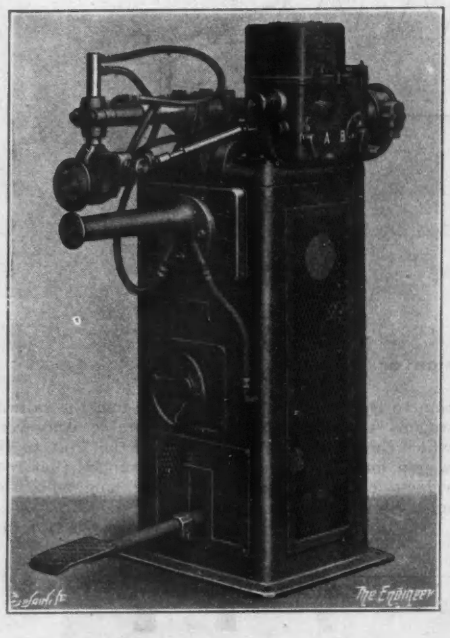


FIG. 3—CIRCUMFERENTIAL SEAM WELDER

(Fig. 3), in which the rollers rotate at 90 deg. to the axis of the arms, and suitable, for example, for welding the bottoms of cylindrical bodies; (3) seam welders, with an arbor-shaped lower arm (Fig. 5). These machines are similar to longitudinal seam welders, but have an arbor

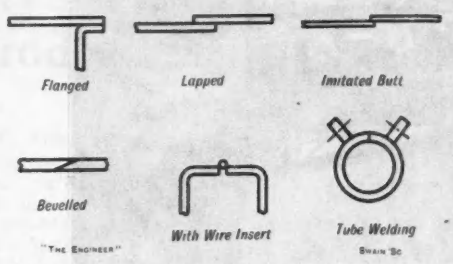


FIG. 4—TYPES OF WELDED SEAMS

instead of the lower roller electrode. They are used when the diameter of the work is too small to enable a roller electrode to be employed. The fitting consists of the arbor proper, connected to the welding transformer and a slide which travels along the lower arm when the upper driven

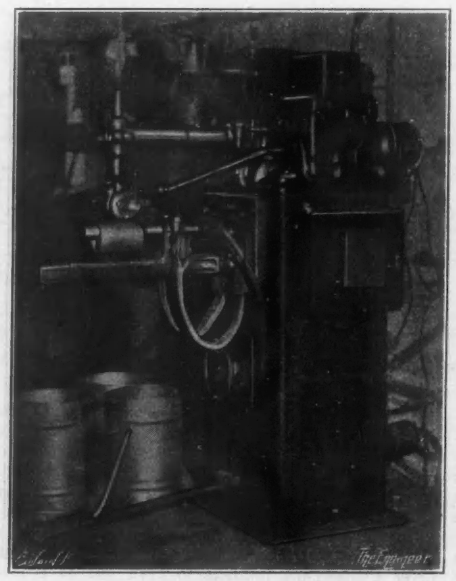


FIG. 5—SEAM WELDER WITH ARBOR AND SLIDE

electrode is brought down on the work. (4) When it is impossible to weld the work pieces on the in and out sides as in the case of knife handles, the hollowware seam welder (Fig. 6) is used. The parts to be formed are clamped in a jig and placed on the lower electrode formed as a table, and are pressed against the upper rotating electrode.

If of the same size these four machines merely need an interchange of the various fittings for conversion from one type to the other. To convert from the longitudinal to the circumferential welder, for example, it is merely necessary to exchange the lower arm, as the upper roller electrode can be swung round through 90 deg. It is also possible to use all these machines as spot welders by replacing the upper and lower roller electrodes by a shaft electrode and tip. Various methods of driving the electrodes are possible. The simplest is to employ belt transmission with a three-step cone pulley to permit welding to be done at three speeds. But this method is only used on small machines. The best scheme is to provide a gear-box with a flanged motor, when the various speeds can be obtained by operating the change-gear levers.

Investigation of the welding operation involves consideration of the connection between the supply frequency

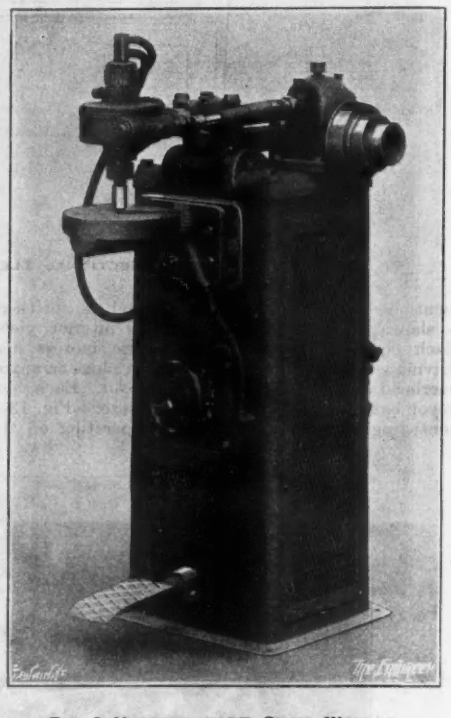


FIG. 6—HOLLOW-WARE SEAM WELDER

and the welding speed. With a 50-cycle supply, a half wave is produced every $^1/_{100}$th of a second. The travel L of the work pieces in that period will depend upon the welding speed V. In the case of a current reversal of 100 times per second (50 cycles supply), during each current loop the electrode will travel a distance L of from 0·125 mm. to 3 mm. and the welding speed V be varied between 0·75 m. and 18 m. per minute, as shown in the following table :—

V (metres/minute).	L (millimetres).
0·75	0·125
1·50	0·25
3·0	0·5
6·0	1·0
9·0	1·5
12·0	2·0
18·0	3·0

The sinusoidal current curve (Fig. 7) and the corresponding energy curve above it, indicate that heat is

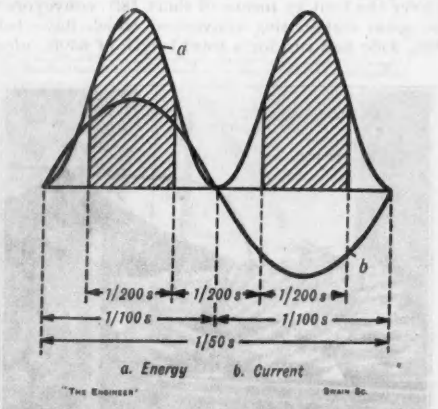


FIG. 7—CURRENT AND ENERGY CURVES

supplied periodically in a sharply rising and falling manner. If the flow of energy is calculated so as to be sufficient to bring the work pieces immediately under the electrodes to a welding temperature within a quarter of a period, a natural cooling period equal to the welding period is secured. To obtain a leakproof seam, it is clear that the separate weld points must overlap each other, for otherwise unwelded portions on the work will lie between the separate spot welds.

Many tests have shown that if a correct amplitude of the welding current is chosen, the pitch of the spots must be in the region of 1 to 2 mm. It follows that in practice it is essential with a 50-cycle supply to weld with an average velocity of 9 m. per minute if use is to be made of the natural rhythm of the energy curve, for the alternating welding and cooling periods. If welding be done at higher

speeds, as it is in special cases, the frequency must be changed by means of a frequency changer. For a welding speed of 18 m. per minute, it would be necessary to use a 100-cycle supply. For velocities considerably lower than 9 m. per minute the frequency should be reduced in accordance with $f = \frac{v \times 1000}{L \times 120}$.

The relation between supply frequency, welding speed

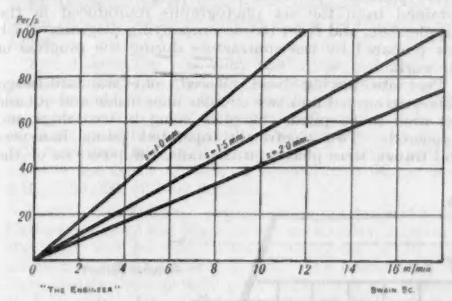


FIG. 8—FREQUENCY, WELDING SPEED AND PITCH

and pitch S is shown in the curves (Fig. 8). If the foregoing explanations be considered, together with the conditions existing at low welding speeds and a supply frequency of 50 cycles, it will be recognised that the pitch of the separate spot welds due to the half-current waves becomes smaller and smaller as the welding speed is reduced. On each unit of length of the seam there are more energy

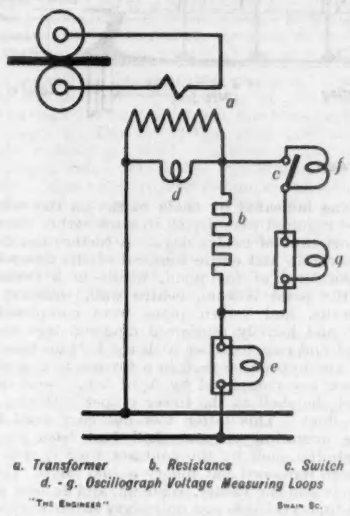


FIG. 9—DIAGRAM OF CONNECTIONS

impulses than occur when the welding speed is higher. The consumption of energy becomes greater than is strictly necessary for a good seam weld, and a larger quantity of heat is consequently introduced into the work pieces.

As this excess heat can only travel laterally to the weld into the body of the spots, it widens the heating zone

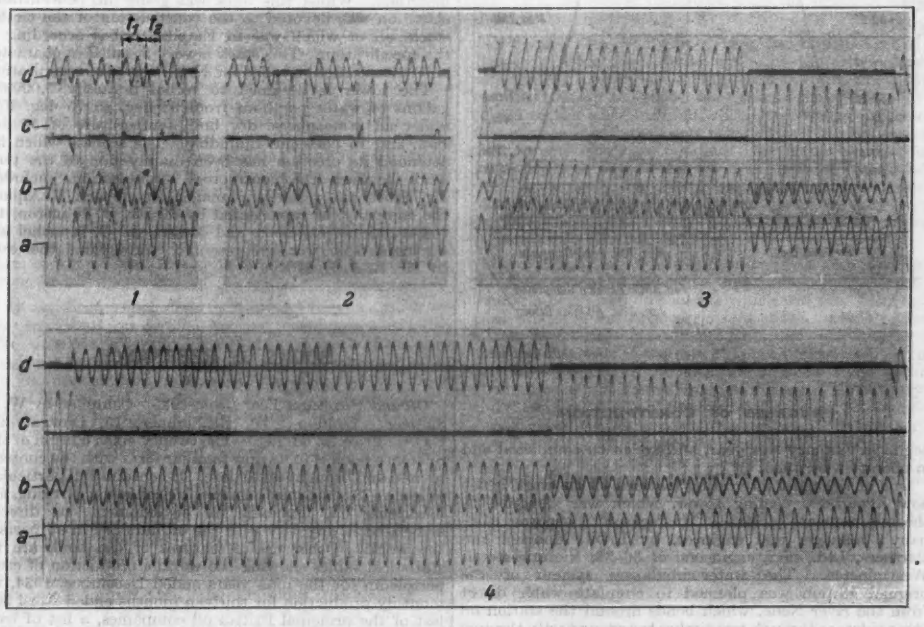


FIG. 10—OSCILLOGRAPH RECORDS FROM SEAM WELDER

along the seam. For several reasons this extra heat consumption of the work pieces is undesirable. Apart from the waste of energy, it increases the stress in the material and causes distortion of the work pieces. The strength and the ability of the seam to resist leakage also suffer, for each point should be allowed to cool off under the electrode pressure before the next part is welded. Under the latter condition each point under the electrode gets a good forging action before the forward movement of the electrode leaves it without pressure. In the case of low welding speed the current must therefore be interrupted rhythmically or must at least be reduced if it is not desired to change the supply frequency.

The time current curve of the supply to the welding electrodes can be changed in different ways. By means

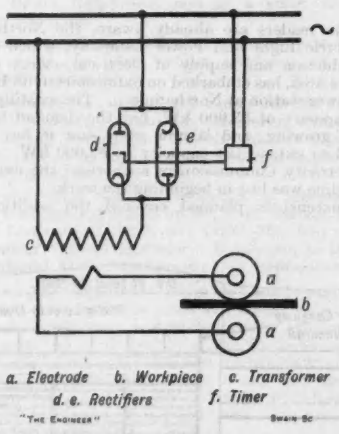


FIG. 11—DIAGRAM OF CONNECTIONS OF CONTROL SYSTEM

of a mechanical switch a resistance can be switched into the primary circuit of the transformer, as in Fig. 9. Parallel to the resistance there is a bridge, so that when the switch operates the resistance is alternatively switched on and off. The usual method is to employ an automatic switch operated by a cam shaft, so that the transformer voltage is increased and decreased alternately. To investigate

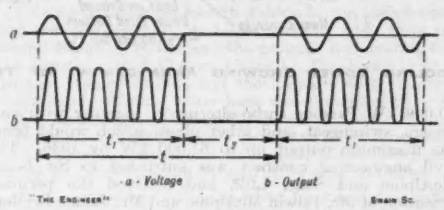


FIG. 12—OSCILLOGRAPH WITH GRID CONTROLLED RECTIFIERS

this method several oscillograph tests have been made on a machine with a small transformer rating and with speeds as indicated in the table below :—

Thickness of material, mm.	Welding speed, mm. per minute.	Transformer tapping.
2×0·5	1242	4
2×1·0	516	6
2×1·5	216	7
2×2	106	7

The mechanical interrupting switch was arranged so that for each test a pitch S of 1·3 mm, or of 2·6 mm., could be obtained. In all, eight oscillograms were taken, and four typical examples are given in Fig. 10. The first two (Nos. 1 and 2) were taken when welding 2 mm. by 0·5 mm. steel with 1·3 mm. and 2·6 mm. pitch respectively ; whereas the last two refer to tests with 2 mm. by 2 mm. steel with the same weld spot pitch. Four functions, *a*, *b*, *c*, and *d*, are shown on each oscillograph strip, and represent :—

	Welding period.	Cooling period.
(*a*) Voltage at transformer primary terminals	E_1 ..	(E'_1)
(*b*) Transformer primary current ..	I_1 ..	(I'_1)
(*c*) Voltage at the switch	— ..	(E_n)
(*d*) Current through the switch	I_n ..	—

The actual measuring points are shown in the diagram of connections (Fig. 9). From the oscillograms both the peak values *a*, *b*, *c*, *d*, and the times of the welding and cooling periods t_1 and t_2, can be taken. Values are calculated below, where S is the pitch of the separate spot welds :—

Total thickness.	S, mm.	t_1, sec.	t_2, sec.	$t_1 : t_2$.
2×0·5	1·3	0·04	0·02	2 : 1
	2·6	0·07	0·05	1·4 : 1
2×1·0	1·3	0·1	0·05	2 : 1
	2·6	0·17	0·12	1·4 : 1
2×1·5	1·3	0·22	0·12	1·82 : 1
	2·6	0·41	0·29	1·4 : 1
2×2	1·3	0·4	0·63	1·74 : 1
	2·6	0·74	0·52	1·4 : 1

From these results the conclusion may be drawn that the relationship between the welding and cooling times is

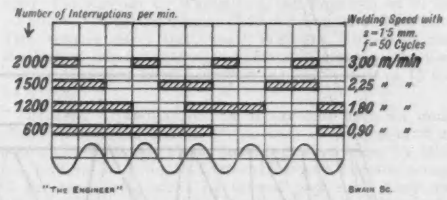


FIG. 13—OPERATING CONDITIONS WITH RECTIFIER CONTROL

practically independent of the gauge, but can obviously be varied between limits which lie between 2 : 1 and 1·4 : 1. If each half wave is sufficient for the welding of a spot, then according to Fig. 7 the relationship is 1 : 1. At the maximum welding speed of 1242 mm. per minute, the welding time is only four half waves. For 1 mm. of seam there are, on the average, including the cooling period, three half waves in round figures. On the other hand, when welding steel of four times the thickness requiring a reduction of the feed to 106 mm. per minute, approxi-

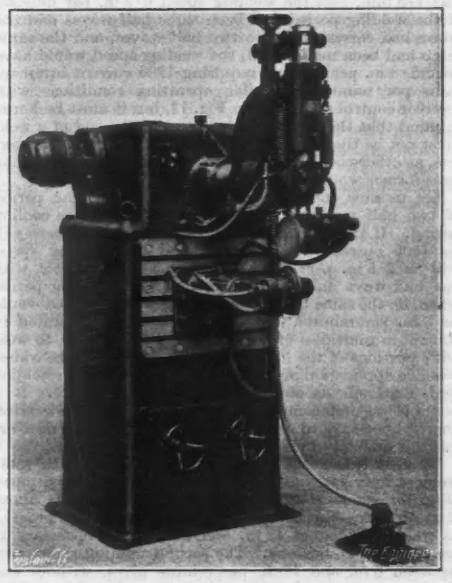


FIG. 14—HIGH-POWER SEAM WELDER

mately ten times as many current fluctuations per millimetre of seam are required, and must have higher peak values, obtained by using a higher transformer tapping.

It is thus shown that the necessary number of half waves per welding spot for a certain thickness of steel is smaller in an inverse proportion to the electrical rating of the machine.

Another matter to be observed is the number of current interruptions per minute necessary at the highest welding

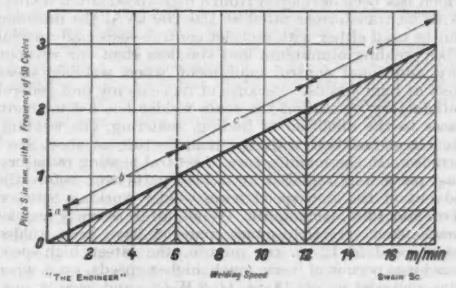


FIG. 15—RELATION BETWEEN PITCH AND WELDING SPEED

speed of 1242 mm. per minute. With a spot weld pitch of 1·3 mm. this is equal to $\frac{1242}{1 \cdot 3}$, or 960 switching operations per minute. Such a large number of switching operations demands arduous duty from a mechanical switch, even if driven by a synchronous motor to ensure that the interruptions occur every time at the value of zero current. For this reason designers have long been endeavouring to find another method of interrupting the current. Use has therefore been made of the rotating three-phase

transformer, known as the modulator, which produces a periodic change of the supply current normal voltage, which is alternatively reduced and increased by about 25 per cent.

But an entirely different method of current control has been made possible by the introduction of grid-controlled rectifiers. The principle of this rectifier is now well known, and it will suffice to call attention to the control system shown in Fig. 11. One of the two rectifiers *d* and *e* passes the positive half and the other the negative half of the current wave. A timing tube *f* imposes a positive or negative bias on the control grids of the rectifiers, thus opening or closing the primary circuit of the welding transformer. As long as one potential is imposed welding takes place, and as soon as the opposite potential is applied to the grid the current is interrupted. The oscillograph for this method of welding is shown in Fig. 12. In this case the welding period was six half waves, whilst the pause corresponded to four half waves. Thus the pitch was 1·5 mm. and the welding speed 0·9 m. per minute. If the welding period had been three half waves and the pause had corresponded to two half waves, and the same pitch had been maintained, the welding speed would have been 1·8 m. per minute, requiring 1200 current interruptions per minute. Possible operating conditions with rectifier control are shown in Fig. 13, but it must be borne in mind that the direction of current at the end of a weld must not be the same as that at the beginning of the next one, as otherwise a one-sided magnetisation of the welding transformer would take place.

Let us now consider operation with a welding period of two half waves followed by a two half wave cooling period. If the pitch of the spots be 1·5 mm., there will be 1500 current interruptions, and the welding speed will be 2·5 m. per minute. It is possible to weld with one half wave and with a two half wave cooling period when, on the same basis as before, the welding speed would be 3 m. per minute. Rectifier control is not limited to control in multiples of half waves. It is possible to weld with portions of the half wave, thus permitting the widest possible application of the method, especially when welding such materials as aluminium, stainless steel, &c. It is possible to determine the exact amount of electrical energy necessary to obtain any spot weld and to measure out this quantity by means of the rectifier method.

There are four distinct speed zones for which seam welders may be constructed and operated. The curve (Fig. 15) shows that if the pitch of the welds is above 2 mm., which is the maximum permissible in practice (a welding speed of 12 m. and over), it is necessary to use frequency changers. The second welding speed zone between 6 m. and 12 m. per minute gives, without any further auxiliary current, a pitch of mesh welds of from 1 mm. to 2 mm. At speeds below 6 m. per minute the pitch of the half waves becomes too small to be used, and it is therefore necessary to introduce current control of the mechanical or electrical type, but it has been shown that owing to heavy wear on the switch mechanical current interruption becomes impracticable for speeds above 1 m. per minute.

The foregoing considerations show that electric seam welding must be regarded as something in the nature of step-by-step spot welding, especially in the case of high-power welding machines, such as that shown in Fig. 14, which has been developed from a high-speed stitch welder. With its transformer rated at 150–200 kVA, the machine can be used either with rectifier control—especially useful when welding aluminium and stainless steel—or without any additional control equipment when welding sheet steel at high speeds. Because of its economy and general satisfactory operation, the seam welder has led in many cases to the abolition of folding, soldering, gas welding, &c., in connection with the manufacture of sheet steel articles. In the manufacture of central heating radiators, cast parts were replaced by welded parts even before the advent of the slow-speed seam welder working between 6 m. and 12 m. per minute. While up to recently articles made from very light-gauge material have been welded at a speed of 12 m. per minute, the latest high-speed machines permit of very much higher speeds, even when the material is of 18 to 14 S.W.G., and enable non-ferrous metals, especially aluminium, to be dealt with.

For the information contained in this article we are indebted to Dr. H. Wilbert and Mr. L. Ferney, of Siemens-Schuckert (Great Britain), Ltd., 30–34, New Bridge-street, E.C.4.

Orders amounting to nearly £300,000 have been placed in this country by the Johannesburg City Council for the supply of trolly omnibuses, tramcars, and conductor wire for the renewal of the transport system.

Hyperbolic Cooling Tower at Northampton

As our readers are already aware, the Northampton Electric Light and Power Company, which controls the production and supply of electrical energy over an extensive area, has embarked on extensions to its Hardingstone power station at Northampton. The existing station has a capacity of 33,000 kW, but the demand has been steadily growing, and is now such that it has become essential to extend the capacity to 63,000 kW. In 1934 the Electricity Commissioners authorised the extensions, and no time was lost in beginning the work.

The extensions planned covered the addition of a 30,000 kW Parsons turbo-alternator, together with new boilers, switchgear, and other plant, which would bring the maximum output up to 61,000 kW by 1936. The civil engineering contract was entrusted to Sir Robt. McAlpine and Sons, Ltd., and received the personal attention of Mr. Edwin McAlpine and Mr. James Brydon. The extensions to the boiler-house, engine-room, and switch-house are being constructed on reinforced concrete foundations. The total number of piles for this section of the work is 450 precast and 160 12in. and 8in. (nominal) diameter pressure piles, each 40ft. long. For the 30,000 kW turbo-alternator a ferro-concrete bed was cast by continuous pouring. All sections of the work were begun in January this year, and are to be completed and in operation by 1936.

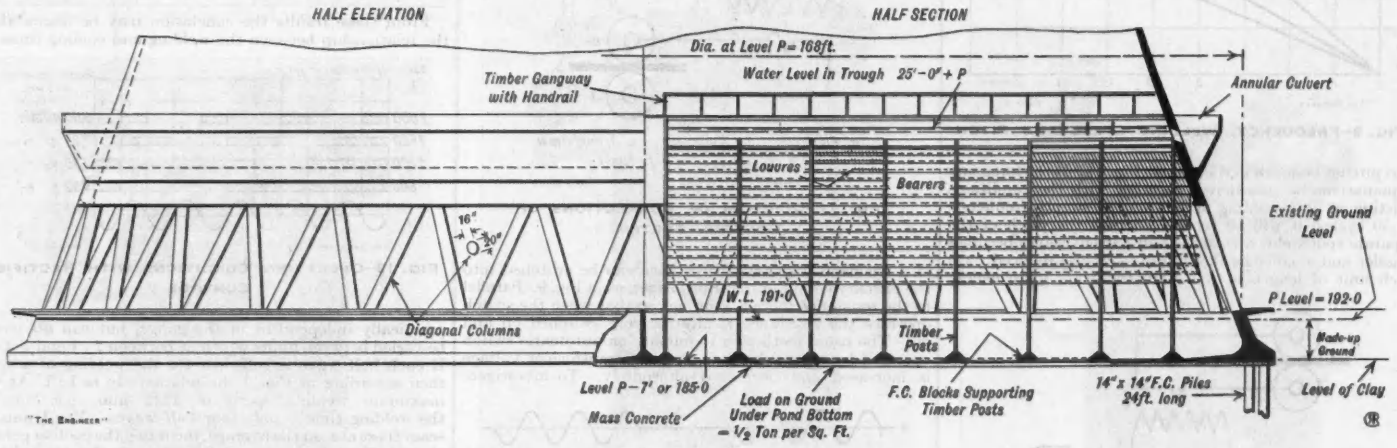
One of the most interesting features of the work is the new hyperbolic cooling tower, which was designed to the requirements of Mr. G. H. Jackson, the power company's manager and engineer, by L. G. Mouchel and Partners, Ltd., civil engineers, of 36–38, Victoria-street, Westminster. The water-circulating system of the original station was planned to circulate water direct from the river Nene, which bends around the station on three sides, or through two timber towers or partly through both. The two old timber towers are seen in the background of the sixth view reproduced in our two-page Supplement. Whilst this older method gave a sufficiently good result for the existing plant, Mr. Jackson, considering the question from every angle, decided that for the extensions a hyperbolic tower would provide the best solution of the water-cooling problem.

The contract for the new cooling tower was let to Sir Robt. McAlpine and Sons, Ltd., on January 19th of this year. The contractors had to pile, excavate, and erect a tower some 210ft. above pond level on a base of 180ft. diameter, and construct ponds, washouts, inlets, and sundry conduit and pipe works all in six months, under a severe penalty. An idea of the progress made may be obtained from the six photographs reproduced in the Supplement, and from the accompanying diagram, which was prepared by the contractors during the progress of the work.

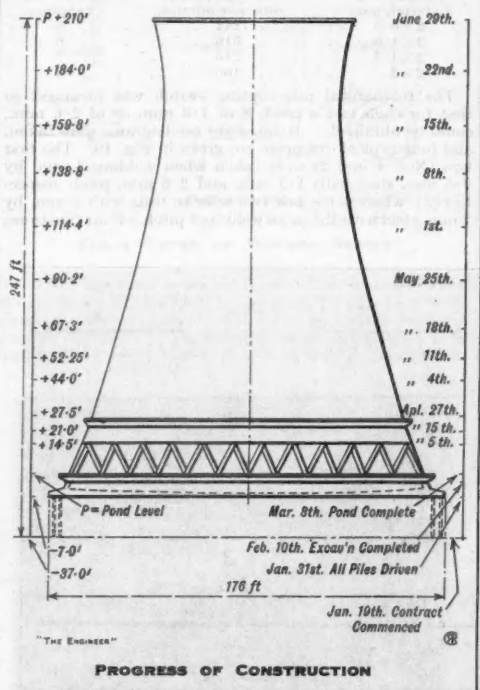
The site having been cleared, old standard-gauge rails were curved into two circular lines inside and outside the area to be piled, the piles being in two rings and staggered. Two electrically operated piling hammers and frames were placed on the rails, the positions of the piles being indicated by chalk marks on the rails. The 128 piles required were driven to a set within the remarkably short time of twelve days. A further ten days saw the excavation and entire removal of the ground to the formation level of the pond, whilst in a further four weeks the pond bottom, centre wall, washout sumps, pond walls, and return pipes were completed. The difficult and heavily reinforced diagonal legs were then prepared and cast together with the bottom beam at the base of the hyperbolic shell in a further four weeks. All this work was completed by April 5th. Next came the 190ft. of the shell to the tower proper with the annular outside duct. This latter was not cast until the last pouring operation on the shell had been completed. To finish the shell by the contract time it will be seen that there remained but ninety actual days. Deducting week-ends and the Easter, Whitsun, and Jubilee holidays, the net time available was only sixty-seven working days. No extra time to cover inclement weather or other disturbances was asked for. Hence, to finish the work in the time allowed it was necessary to complete about 3ft. of the shell each working day, or, working round the clock, including week-ends and holidays, something like 2ft. a day. The work was duly finished by the contract date.

The contractors, Messrs. McAlpine, used tubular scaffolding and steel and timber shuttering, the erection of which was kept well in advance of the concrete. In addition, electric hoists were employed for the rapid handling of materials. Whilst this work was going on, concentrated attention was devoted to the construction of the timber stack, all of which was in Empire timber according to the specification. This stack is very detailed in character, and its construction called for a high degree of organisation.

The tower is designed to recool normally 3,000,000 gallons of water per hour from 95 deg. to 75 deg. Fah. under an atmospheric dry bulb temperature of 55 deg. Fah. and 75 per cent. humidity. The success which has attended its erection has been mainly due to the team work between the contractors' organisation, including Mr. Scott, the resident manager for Messrs. McAlpine; the company, as represented by Mr. G. B. Johnston, the constructional engineer, and Messrs. L. G. Mouchel and Partners, who were represented throughout the work by Mr. B. A. E. Hiley.



BASE OF COOLING TOWER SHOWING ARRANGEMENT OF TIMBER STACK



PROGRESS OF CONSTRUCTION

BOOKS OF REFERENCE.

Oil and Petroleum Year Book, 1935. Compiled by W. E. Skinner. London: W. E. Skinner, 15, Dowgate-hill, E.C.4. Price 7s. 6d. net.—The twenty-sixth edition of this reference book is in its now familiar form with the contents revised and brought up to date. It contains full particulars of some 678 companies engaged in producing, carrying, and marketing oil, financing oil development, or directly associated in any way with the oil industry in all parts of the world. Other useful features of the book are the statistical tables showing the world's production of crude petroleum for the nine years ended December, 1934, the monthly production for thirteen months ended April 30th last of the principal British oil companies, a list of trade names of petroleum products marketed by the various companies, and a glossary of technical terms and words peculiar to the oil industry.

A battery of fifty-nine coke ovens, capable of carbonising 1000 tons of coal a day, is being erected at Brancepeth Colliery, Wellington. The development is the largest to be embarked upon in South Durham for several years, while the plant will be the most modern and up to date of its kind.

Rail and Road.

THAT great North American railway system known as the New York Central Railroad Company was a combination, made in 1869, of the New York Central Railroad and the Hudson River Railroad, which was known as the New York Central and Hudson River Railroad. It has now again changed its name to that of the New York Central Lines.

THE August Bank Holiday traffic was included in the published traffic receipts for the thirty-second week. It is opportune, therefore, to remark that at the close of that week increases over the corresponding period of 1934 were reported by all the companies. They were respectively :—L.M.S.R., £468,000, or 1·28 per cent.; L.N.E.R., £93,000, or 0·35 per cent.; G.W.R., £151,000, or 0·99 per cent.; S.R., £123,000, or 1·00 per cent.

THE "Silver Jubilee" express of the London and North-Eastern Railway will begin to run on Monday, September 30th. It will be due to leave Newcastle at 10 a.m., arriving at King's Cross at 2 p.m. The return train will leave King's Cross at 5.30 p.m. and be due at Newcastle at 9.30 p.m. For the convenience of Middlesbrough, Stockton, and Hartlepool passengers the train will stop at Darlington in each direction. The journey of 268 miles is timed to be made in 4 hours.

THE road traffic census, mentioned on page 648 of our issue of June 21st, was carried out during the week beginning August 12th. It covered every highway in the country with the exception of the County of London. Special interest will be taken in the count of the horse traffic, in view of the announcement by the Minister of Transport that he is considering the possibility of restricting such traffic on certain roads. Pedestrians were numbered at 2550 points where there are no footpaths or where those in existence are 3ft. or less in width.

THE association between the proposed Wandsworth by-pass and the first public railway of 1801, mentioned herein on page 139 on August 9th, has been recognised in other quarters. The stones that were used as sleepers when the railway was built were subsequently employed in building a wall in the public roadway of the old Red Lion Inn. The latter is now redundant and it, and its offices annexed, may probably be pulled down, and possibly the stones, in ignorance of their historical interest, will be discarded and thrown aside. The *Wandsworth Borough News* therefore proposes that the stones might be recovered and preserved and placed in, say, King George's Park or other suitable place, as a reminder and record of the enterprise.

IN view of the fact that it was ten years ago on July 12th, 1935, since electric traction was introduced from Victoria and Holborn to Orpington *vid* Herne Hill and the Catford loop and to Crystal Palace, High Level, the *Southern Railway Magazine* has published some figures comparing the number of tickets issued from certain stations in 1934 with those in 1925. At Beckenham Junction the 277,338 of 1925 was increased to 394,808; at Crofton Park the 242,115 to 338,753; at Bellingham, the 164,025 to 313,743; and the 272,060 at Orpington to 403,451. From the additional station at Petts Wood there were 320,597 tickets issued in 1934. There had also been a large increase in the number of season tickets; the biggest increase in that category was in the 2677 of 1925 at Orpington, which rose to 13,378.

THE Institute of Transport provides for graduate and associate membership for persons engaged in the road transport industry, but up to the present time there has not been any scheme on a national scale for those who cannnot take the examination for those grades. To meet this need a special committee of the Institute has been, for three years, considering a way whereby the desired provision for non-administrative staffs in the road transport industry could be made. Such a scheme is now announced. There will be syllabuses to cover a three years' course of study and the Royal Society of Arts will hold examinations and issue certificates to persons who are successful. Those passing in the three subjects of a year's course may be awarded course certificates; single subject certificates will also be awarded. Those passing in all the subjects of the three years' course will be awarded a "Diploma in Road Transport." The certificates will be available for members of the staff, inspectors, drivers, conductors, garage and shed workers, in fact, every grade of employee engaged in goods or passenger transport by road by any class of vehicle and including tramway, railless traction, or motor bus operation.

IT was twenty years ago on August 14th since the down day Irish mail was derailed and ten passengers were killed. The cause of the derailment was that the track of the down road was badly displaced as the mail was approaching by the failure of the right-hand coupling rod of engine No. 1489, of the 4–4–0 type and "George the Fifth" superheater class, on an up express. When the latter train stopped at Rugby, on its way from Birmingham to Euston, the driver noticed that the split pin was missing from the right-hand driving crank pin washer. A split pin was taken off another engine and used on No. 1489; the fitter had no chisel with which to open the split end of the pin so he used the jaw of a ¼in. pin spanner. When the Birmingham train was subsequently on the Euston side of Weedon and travelling at about 60 m.p.h. the engine gave a lurch and the driver saw the ballast flying. The train was stopped and the coupling rod was found detached at the leading end, but in a position that many locomotive authorities said, at first, was impossible—it had got round into the trailing position, in which it was found when the engine came to rest. The split pin had worked loose and was afterwards found at a point 8 miles south of Rugby and the screw washer was picked up 4¼ miles further on. As the late Colonel Druitt said in his report: When the washer came off the coupling rod would have a tendency to whip about like a thin metal band when held vertically and shaken and so come off the crank pin. It would then fall in a forcing direction and hit the ballast and become considerably bent and sufficiently so for it to get round into the trailing position. But in so doing it hit the end of a sleeper in the down road and so displaced the track as the down mail was approaching.

Miscellanea.

ON Monday night a disastrous fire broke out at the great Berlin Radio Exhibition, and in a short time much damage was done.

WHEN a small percentage of aluminium is added to Monel metal the alloy, whilst retaining its strength, becomes non-magnetic.

ON Tuesday last part of the tunnel for the new north to south underground railway in Berlin collapsed and buried a gang of workmen. The collapse left a deep crater some 50 yards long, and it is believed that fourteen of the men lost their lives.

IT is announced that Sir Josiah Stamp, president of the L.M.S. Railway, supported by Mr. S. E. Garcke, President of the Institute of Transport (1934–35), will open the seventeenth "Model Engineer" Exhibition at the Royal Horticultural Hall, Westminster, on September 19th.

THE longest suspension bridge in Canada and the first to be built entirely to the plans and under the supervision of Canadian engineers is now practically completed. It crosses over the north branch of the St. Lawrence River, between the Island of Orleans and the mainland of Quebec, one end being a few miles east of the City of Quebec. The bridge has a total length of 5820ft., with a suspended section 2370ft. long; it carries a 20ft. wide roadway and two 5ft. footpaths.

THE Paris Municipal Council has passed for consideration a scheme for the construction of a stadium to be built over the present Ceinture railway. The scheme will make use of valuable ground area in the centre of Paris, at present occupied by the railway shunting yards. By roofing in these yards, a building could be constructed above them which it is proposed to make into a series of covered tennis courts, enabling high-class tennis matches to be played all the year round in the heart of Paris. The project is intended to be self-supporting.

AS a memorial to the late Sir Ashton Lister, their founder and first chairman, R. A. Lister and Co., Ltd., have presented Kingshill House and the grounds surrounding it to the Dursley Rural District Council. The house is to be used as Council offices, and the grounds as a children's playground. Messrs. Lister have also presented a portion of the land adjoining Kingshill House to the Council for the erection of Council houses in order to relieve congestion in the district. According to present plans, 150 houses are to be erected by the Council on or near the estate.

AT a convention of the Canadian Chemical Association the properties of acetylene black as a thermal insulator were discussed. An abstract in the *Chemical Trade Journal* states that acetylene black possesses excellent thermal insulating properties, due entirely to the porous or cellular structure of the black, which has an apparent density of less than 2 lb. per cubic foot. The true density of the carbon itself is about 125 lb. per cubic foot. The thermal conductivity of acetylene black, as determined by the National Research Laboratories, is 0·22 B.Th.U. per hour per square foot per inch per degree Fahrenheit at 70 deg. Fah.

NEARLY one hundred municipal authorities and important bodies connected with the gas, electrical, and solid fuel industries will be represented at the seventh annual conference of the National Smoke Abatement Society, which is to be held at Bristol from September 19th to September 21st. The conference is to devote a special session to the question of smoke abatement and the coal industry, and it is anticipated that important recommendations regarding the use of raw coal will be made. Special consideration is also to be given to smokeless equipment in housing schemes, the emission of dust and grit from industrial chimneys, and the effect of smoke drift on the countryside.

WE have already reported that the British Cast Iron Research Association is contemplating the establishment of a British foundry school and that the governing body requires to have ten students to ensure the opening of the school in the early autumn. To date, we are informed, five applications have been received and we understand that several others are pending. As the governing body, in making arrangements for the opening, must take definite steps during the present month, firms contemplating sending members of their staffs, or any other students desiring to enter, should send in their applications as soon as possible.

UNDER the title of "Forest Products Research Records," the Department of Scientific and Industrial Research is issuing a new series of booklets which will give the results of all phases of the work carried out at the Forest Products Research Laboratory. The "Records" will appear at irregular intervals at the rate of approximately ten a year. The first two of these booklets are entitled "The Testing of Timbers at the Forest Products Research Laboratory" and "Strength Tests of Structural Timbers"; they have already been issued, and future numbers of the new series now in course of preparation deal with experiments in the preservation of timber; seasoning and the moisture content of timber in new buildings; while other numbers will contain information on the general properties of various species of timber on wood-working and on fungus and insect pests of timber.

AS a result of a cloudburst on August 13th, the dam above Ovada, in Piedmont, burst, releasing about 15,000,000 cubic yards of water from Lake Orbicella. The water swept through the valley of the Orba, destroying practically the whole of the town of Ovada and flooding the valley almost to Alessandria, 35 miles away. A second dam, which was at first expected to burst, held back the remaining water of the lake. This dam has been examined and pronounced perfectly secure. It is difficult to assess the damage, but the dam which burst, together with its power station, cost £600,000 to build. Some hundreds of persons have lost their lives and many more are missing, but owing to the panic which occurred after the flood many people are believed to have sought refuge in the mountains. The deaths are largely attributable to the inhabitants having taken refuge from the cloudburst in their houses just before the water trapped them beneath the falling masonry.

Air and Water.

THE old Admiralty yacht "Enchantress" has left Portsmouth for Blyth, where it is understood she will be broken up.

THE Greek Government has, according to reports, decided to purchase forty-five bombing and reconnaissance and twenty-five instruction aeroplanes from this country.

THE P. and O. liner "Mantua," now outward bound to China, has been sold to Chinese shipbreakers. She is an 11,000-ton vessel having a speed of about 16½ knots, and was built in 1909.

ACCORDING to reports, plans have now been accepted for a new aerodrome at Fanling on British-leased territory at Hong Kong. It is expected that the new aerodrome will be occupied towards the end of the year.

THE motor vessel "Wairangi" has made a record passage for a laden ship from London to New Zealand. She made the run out to Wellington, *vid* Panama, in 30 days 10 hours, the actual steaming time being 29 days 2 hours. This vessel's sister ship, the "Waiwera," has also made the fastest trip for many years from England to the Cape, having travelled from Liverpool to Table Bay in 15 days 14 hours.

GRIMSBY CORPORATION, in accordance with an understanding reached before it financed construction of the new £1,500,000 fish dock, has adopted a lease by which the London and North-Eastern Railway become tenants of the new dock, until, by annual payments, they have refunded to the town the cost, after which the Corporation will hand the dock over to the company to become their own property.

THE Cunard White Star liner "Olympic" is to be thrown open from Monday next for inspection, with a view to selling the vessel. She was built at Belfast in 1908 and launched in 1910, at which time she was the largest ship afloat, with a gross tonnage of 46,000, and her combined turbine and reciprocating machinery gave her a speed of 23 knots. With the exception of the "Queen Mary" now fitting out, the "Olympic" is still the largest British-built ship afloat.

THE increase in air traffic between England and India necessitated, in January last, the duplication of the weekly service between London and Calcutta. Since then the growth in passenger, mail, and freight traffic, not only between London and Calcutta, but onward to Singapore, has rendered it necessary for Imperial Airways to arrange to extend this twice-weekly service, so that, in addition to the London-Calcutta stages, it also embraces the sections between Calcutta and Singapore.

A NEW motor lifeboat built on the Clyde has been presented to the Royal National Lifeboat Institution's branch at Port Askaig, Islay, off the West Coast of Scotland. Port Askaig is a new station, established last year. The new boat is named "Charlotte Elizabeth," and is of the cabin type, 45ft. 6in. long, with two 40 h.p. engines, carrying enough petrol to travel 116 miles at the full speed of 8¼ knots. The boat can take ninety-five people on board in rough weather.

IT is understood by the *Journal of Commerce and Shipping Telegraph* that tenders have been invited by the Admiralty for re-engining H.M. battle cruiser "Renown." The machinery at present fitted in the "Renown" consists of four sets of Brown-Curtis direct-drive turbines coupled to four propellers. Steam is supplied by forty-two Babcock and Wilcox boilers at a pressure of 250 lb. per square inch. The designed horse-power is between 110,000 and 120,000, but on trials the "Renown" developed 126,300 s.h.p. for a speed of 32·68 knots.

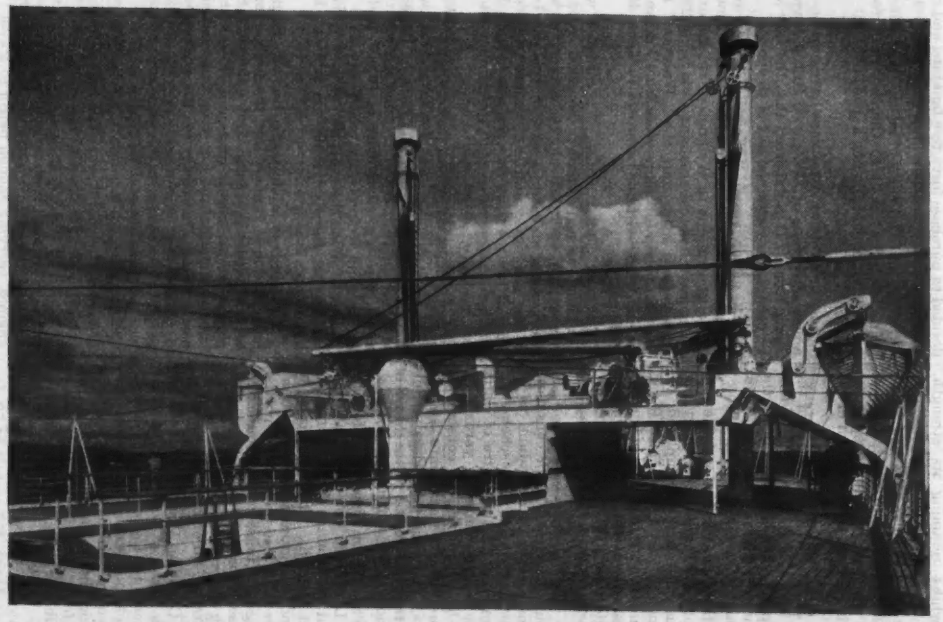
IN accordance with the Federal Ministry's proposal to make Australia independent as far as possible of war material from overseas, the munitions factory at Maribyrnong, near Melbourne, is being made the nucleus of a large industry for meeting the many requirements of the Royal Australian Air Force and civil aviation, says *The Times'* correspondent. Six "Moths" for the R.A.A.F. are being built, and it is understood that authority has been obtained to manufacture Hawker "Demon" and Supermarine "Seagull" amphibian machines. It is intended later to manufacture various types of engines for aircraft.

FROM a note in *Flight*, discussing the amount of publicity which is given by newspapers to aeroplane accidents, we quote the following:—"People are not allowed to know about the thousands of miles which are flown every day and the thousands of passengers who are carried without even the slightest incident. Just as an example, because military flying is admittedly far more dangerous than civil flying, and is therefore better for our purpose, let us quote the fact that 356 aircraft which took part in the recent Air Exercises flew a total of some 4000 hours, mostly at night and often in fairly bad weather, a distance of about 400,000 miles being covered. During this time one man was a little bruised in a forced landing!"

MANY amendments to the general rules and regulations of the U.S. Bureau of Navigation and Steamboat Inspection have recently been approved by the Secretary of Commerce, and now have the force of law, says the *Journal of Commerce*. Many of these amendments concern lifeboats and life-saving apparatus, and it is of interest to note that, by one section, the provision of a hand-operated propeller of an approved type is compulsory for all lifeboats, other than motor boats, having a capacity for sixty or more persons. Gear of this type may also be fitted in smaller boats. The section provides that the hand-propelling gear shall be substantially constructed and fitted in the boat in an efficient manner, and be such that the boat may be readily manœuvred away from the ship's side after being launched and steerageway maintained under adverse weather conditions. The gear shall be of such a character that it may be operated by persons untrained in its use. It shall be such that it can be operated satisfactorily when the boat is partially flooded, and will be effective in propelling a boat fully or partially loaded. This propelling gear is required in all such lifeboats fitted in new vessels and to the lifeboat replacements on existing vessels.

THE ORIENT LINE STEAMER "ORION"

VICKERS-ARMSTRONGS, LTD., BARROW-IN-FURNESS, BUILDERS



ABOVE: SPORTS DECK
BELOW: FIRST-CLASS BATHING POOL

ABOVE: TOURIST DECK AND SWIMMING BATH
BELOW: FIRST-CLASS DINING SALOON

The Engineer

AUGUST 23, 1935.

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TWO-PAGE SUPPLEMENT—CONSTRUCTION OF A REINFORCED CONCRETE COOLING TOWER AT HARDINGSTONE, NORTHAMPTON.

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DEATH.

On Thursday, August 1st, Doctor ARTHUR DEHON LITTLE, Chairman of Arthur D. Little, Inc., Cambridge, Massachusetts.

ORGANISING THE STEEL MARKET.

EVEN before the agreement between the British Iron and Steel Federation and the Continental Steel Cartel was signed, it was realised that many difficulties would have to be overcome before its provisions could be put into operation. It is to the good, therefore, that the negotiating committee has departed for a well-earned holiday until September, as this will allow the pools and committees which have to put into practice the arrangements for marketing Continental steel in the British market time to introduce order into the confusion which now exists. The total tonnage of the various descriptions of steel which are included in the agreement having been settled, it has been left to these subsidiary bodies to divide the total into various classifications, and for this purpose existing organisations have been utilised. For some years the Continental sales offices in London have worked through committees which have pooled the orders received from British consumers. Representatives of British steel makers have been appointed to these organisations, and a pool has been set up to deal with each description of steel, such as joists, plates, strip, &c. The practical work of filling in the broad details of the agreement is not made easier from the fact that consumers who remained quiescent to a great extent whilst the negotiations were being conducted, are awakening to the fact that their interests are threatened in some directions. As recorded elsewhere in this issue, Lord Nuffield, for instance, has voiced his feelings in no uncertain manner, and other consumers are becoming distinctly restive under the new conditions and the prospect of further changes which are not likely to be to the advantage of users of iron and steel.

Perhaps one of the most troublesome problems which has to be faced is provided by the arrangement that Continental prices must be advanced to within 10s. of the British makers' quotations, and that the Continental extras list shall be brought into line with the British list. Even when basis prices have been brought within the required limits, the extras lists as they now stand would result in extraordinary differences in the prices of similar British and Continental sizes and qualities. This fact can be readily understood when it is remembered that there has always been a wide disparity in the practice of British and foreign steel makers regarding extras which, in some cases, have differed by as much as two or three pounds. It is not likely that the price of Continental steel will be raised to British buyers for some weeks, although, in effect, the price already has been increased as a result of the reduction in the import duty from 33⅓ to 20 per cent. It was decided that this reduction should be so arranged as to benefit the Continental steel makers and compensate them in some degree for the loss of tonnage they had suffered through the restrictions placed upon imports. This result was achieved by raising the f.o.b. price of Continental steel and making unprecedented distinctions in the quotations for different parts of Great Britain. For instance, in the case of merchant bars the price was raised from £4 10s. f.o.b. to £5 1s. for Birmingham, and to £5 6s. 6d. for other districts. A further alteration has been effected by introducing a difference in the prices of the smaller sizes of structural steel which do not come within the British Steel Makers' Rebate Scheme. These decisions cut across a number of contracts existing between British buyers and Continental steel makers, which include a clause making the buyer liable for any rise in the duty and giving him the benefit of any reduction. It is a fairly clear indication, however, of the state into which the British consuming trades have been dragooned that there have been few protests against an arrangement by which the "fall" clause of the contract has been ignored by the Federation and the Cartel. Of course, no agreement between these two organisations could deprive the buyers of their legal rights if it came to the point; but few, if any, have cared to risk incurring the enmity of both their British and Continental suppliers, so that this part of the agreement may be said to have gone through without a hitch.

For the most part the work of the committees since the agreement was signed has been devoted to dealing with the problems presented by the British home market; but in at least one instance a decision has been reached upon export business. Boiler plates, which, some months ago, were brought under control by the British steel makers and the price raised from about £7 10s. to £8 5s. f.o.b., have now been taken in hand by the Committee of British and Continental steel makers with somewhat startling consequences. The new British boiler plate price for export is apparently based on some obscure gold quotation, whilst sterling prices have been arranged which vary according to the destination of the material. This has resulted in some unusual f.o.b. quotations. For instance, for China the price is £9 4s. 8d.; for Japan and Manchuria, £8 18s. 6d.; for Sweden, £8 19s., and for other countries, including some Empire countries, £9 5s. 9d. It is understood that the Pool dealing with this material will have authority to revise prices and allocate orders, so that foreign buyers may not always be able to buy the material from the country or works with which they wish to deal. The arrangement also seems to be aimed partly at curtailing the activities of merchant exporters, and it is stated that in certain instances the British and Continental works will not quote to merchants. Some works, in replying to merchants' inquiries for boiler plates, have stipulated that the quotation is made on the understanding that the material is not for direct delivery to railway companies. It is not surprising that these developments have occasioned no little alarm amongst sections of the trade, which have been accustomed to handle this class of steel in the ordinary course of business. It would seem, however, that it is the intention of the producers to keep a tight grip upon all material which is bought in considerable quantities by the more important users. This is a policy which the British steel makers for many years past have endeavoured to follow. On the other hand, it has been contrary to the practice of the Continental steel works, and it will be interesting to see whether a similar control is effectively exercised over the foreign merchants. The general organisation and details of the agreement between the Continental and British steel makers governing export trade will not be discussed until September. So far the arrangement is that the 1934 world's export figures will be taken as the basis of any agreement which may be reached. The market, however, will be interested to learn whether this formula is to be applied to individual markets, or to the total world export trade.

The Engineer in Transport.

WE conclude in the present issue the series of four articles on "British Railways as a National Asset," which we began on August 2nd. A primary object was to show the part our railways play in the financial, commercial, and public life of the country. The financial aspect is seen, for example, in the fact that their capital expenditure has been £1174 millions, that they purchase material to the value of £35 millions a year, and burn £11 millions worth of coal in their locomotives, and that they pay out £100 millions a year in salaries and wages to nearly 600,000 railway servants. The extent to which railways help in the commercial affairs of the country may be gauged by the fact that they carried in 1933 269 million tons of freight, of which 46 million tons were of general merchandise and 177 million tons were of coal, coke, and patent fuel. The association of the railways with the general public lies mainly in the passenger traffic. Therein 1100 million journeys were made in 1933, and it is instructive to note that of this enormous number of travellers practically only one in every six paid the full legal fare. The above details, except that of capital expenditure, relate only to what is officially known as railway working. The railways contribute also to the prosperity of the country through being the owners of docks, steamboats, and canals; they also serve the public as owners of hotels and refreshment rooms. In these subsidiary businesses about £165 millions are invested. Railway companies share with traders and the general public in the bad times that come to the country occasionally, such as those that followed what the railways regard as the last normal year, that of 1929. The fall from 400 million tons of freight in 1929 to 306 million tons in 1932 brought down the freight traffic receipts from £103½ millions to £79 millions, whilst railway business generally reduced the £184 millions of gross receipts in 1929 to £144 millions in 1932. Efforts were, of course, made to reduce the expenditure to suit, but that cannot as readily be done on a railway as in many other industries. Whilst trains may be reduced in number, the same facilities must be afforded for little traffic as for normal conditions. There are, again, many directions in which the upkeep has to be the same, notwithstanding the reduced business. Thus, whilst the traffic in 1932 was two-ninths less in value than in 1929, the expenditure on operation could only be reduced by less than one-seventh.

Surveying what the railway engineer has done during the brief period immediately preceding and following the financial crisis of August, 1931, we find, as we have just said, that the expenditure on the railways was reduced by one-seventh in three years; the actual figures were £144·3 millions in 1929 reduced to £122 millions in 1932. Towards that end the mechanical engineer, in his maintenance of rolling stock, brought his expenditure down from roughly £27 millions to less than £20 millions, or to 71·70 per cent. of his 1929 cost, and the civil engineer lowered his £22 millions to £18·6 millions, or 84·32 per cent. of his expenditure in 1929. Between them, therefore, they saved £11 millions towards the loss of £40 millions in traffic and nearly one-half of the total reduction of £22·3 millions in the expenditure of 1932, as compared with 1929. Traffic expenses during the same period were reduced by £6·7 millions and locomotive running by £3·7 millions. This last figure reflects the necessity imposed on the railways to maintain the facilities for the transport of freight and passenger traffic, lest it should go to the roads. The tonnage of freight in 1932 was only 76·50 per cent., or just over three-quarters of what it was in 1929, but the freight train mileage, required to maintain the transport facilities by a reduced load per wagon and reduced loading per train, could be brought down to only 85·27 per cent. To prevent the passenger business from going to the roads was a greater problem, and the passenger train mileage could be reduced by only 0·6 per cent. Those efforts were rewarded, as, despite the still severe competition of passenger road transport and the reduced amount of money spent by the people, there was a fall of only 8·6 per cent. in the number

of passenger journeys, or one in every twelve. It is safe, therefore, to say that the wear of the track, of the locomotives, and of the carriages was not much reduced, so that it was very creditable to the civil and mechanical engineers that they were able to effect the economies which they achieved. These were not effected by what may be called ordinary every-day economy—"here a little, there a little"—but by a wholesale attention to detail, great and small; by greater attention, for instance, to the manufacture of stays for locomotive boilers and in the tapping of stay holes, up to halving the number of types of locomotives in the mechanical engineer's department, and by reducing the rail fish-plate from 18in. long with four holes to 10in. long with two holes, up to the provision of motor-operated platelayers' trolleys in the civil engineer's department.

We have, on sundry occasions within the last thirty years, offered editorial comments under the title "The Future of British Railways." Sometimes these remarks have been inspired by a suggestion that they should be nationalised. That idea, for some time now, has been dead; the railways have so depreciated in value that their acquisition by the State would now be considered a burden. Since 1918, when the Wilson Fox Committee dealt with the very wide subject of "Transport," the railway situation has been quite revolutionised. The Ministry of Transport has been established; the Railways Act, 1921, formed the main line companies into four groups; the trader has been protected by the Railway Rates Tribunal and the companies by the standard charges clauses of that Act; and there has arisen the competition of the roads for passenger and freight traffic. Road transport of freight traffic has come to stay. The benefit of loading a consignment at the works or mill and not having to disturb it until it reaches its destination gives the roads an immense advantage. There must, however, in long distance traffic, be a limit of distance at which it becomes more costly to transport by road than by rail. The companies are therefore wise in accelerating, as they have been doing, their long-distance freight trains. The railways have an enormous pull over the roads in that they are only four concerns and divide the whole kingdom between them. Moreover, by their pooling agreements, they have practically abolished competition between themselves. Coupled with these features are their equipment for the operation of the railways; a long-established knowledge of their business and the outstanding ability of their administrators. These advantages would have to be taken into account in the event of any proposals being made for a National Transport Trust, based on the London Passenger Transport Board, such as is advocated by some of the railway unions.

Scour in River Beds.

By M. G. IONIDES.

THE problem of scour in rivers downstream of control works has received close attention in recent years and many devices have been developed to reduce or avoid it. One aspect of the question seems, however, to have been left comparatively unstudied, namely, the natural tendency of many rivers to change their beds irrespective of the presence of any artificial means of control. This is a most important and variable factor, and should play a large part in the consideration of alternative designs and in the development of anti-scouring devices; but proper allowance is a matter of great difficulty, because no accepted criterion exists for this feature of a river's character. The factor of ignorance is therefore unduly large and has to be covered in hard cash.

A preliminary to the design of a control structure is, of course, a survey of the bed at the site, and series of sections may be taken at varying points and times. Comparison of these sections one with another will show up whether or not the bed is stable, but there is much information in a single section even, and when confronted by a number of them it becomes a sheer impossibility to form a sound mental judgment on their significance. Some system of analysis is essential.

The subject is a wide one and calls for the development of precise statistical methods such as have been so increasingly applied of recent years to most branches of science, but have been slow to find application to river records. Many of these methods can be applied approximately in a graphical form, however, with comparative simplicity, and, indeed, this is a very sound step towards the more accurate analytical technique. In the notes which follow the writer has indicated how the problem of bed variation may be thus attacked.

A question which often arises is that of the maximum scour which may occur at a specified site, to deal with which it may be assumed that a number of cross sections taken at the site itself and perhaps elsewhere on the same river are available. The problem may be studied from two angles. It may be required to estimate the greatest scour which may occur at a definite point, or the greatest scour which may occur irrespective of the exact point where it may happen. Taking the first question, each cross section between a pair of defined points contributes two figures, the water level at the time when it is taken and the greatest depth observed, and when these figures have been picked out from the available sections all the data directly relevant to the problem are at hand.

If now the greatest depth be plotted against its corresponding water level for each defined section, a group of points will result having a greater or less degree of scatter, and it is plain that the greater the variability of the bed at the lowest point the greater will be the scatter of the points. Inaccuracy in the observation of the depths will, of course, have its effect in scattering the points, and means for investigating this will be touched on later, but it will be neglected for the present. It is easy to see that these points will be grouped roughly round a line having a slope of 1 : 1, but that the degree of scatter may vary with the water level. Let two lines be drawn on each side of the group to mark their boundaries, due allowance being made for the fact that their frequency may vary at different levels. These lines may either be parallel or diverge, and the two types are illustrated in Figs. 1 and 2.

The average line running through the points may now be considered as the line of average greatest depth in the section. If a point lies to the left of this line, then the depth at that time was less than the average, and *vice versâ*. Since the variability of the greatest depth is measured by the scatter of the points the two lines give the limits to which depths have been confined in the records used, and may be assumed, therefore, to give an indication of the limits to which the greatest depth may go in the future, though, naturally, their reliability as a guide depends on the number of sections available and on the period over which they were taken.

If the boundary lines are parallel, the interesting and valuable conclusion can be drawn that the variation in greatest depth is independent of the water level, and hence that the low-level sections give as good information as to the greatest depth as the more difficult and costly observations taken during the flood season. This is not to say that the river is as likely to scour during the low season as when the velocity and the level are high. But it does show that, though the bed may change more rapidly and more often during the flood, it is as likely to be left with a deep scour in it as with a shallow one, and that this deep scour will not necessarily fill up again later on when the levels begin to subside. Thus during the low season points may tend to group themselves in lines and at high levels to be scattered, though the boundaries may be parallel.

If, on the other hand, the lines diverge as the depth increases, it means that the limits of variation of scour are greater when the river is up than when it is low. More sections will be necessary when this characteristic is displayed than when the lines are parallel, and more care must be used in plotting the boundary lines and in extrapolating.

The case of lines converging as the level increases may be ruled out, since this would indicate less scour at high levels than at low, a state of affairs difficult to imagine.

Suppose now that the boundary lines have been drawn in, and that there are sufficient points to warrant the conclusion that they represent safe limits. The highest anticipated flood level may now be applied to the line representing greatest scour to find the greatest likely depth, and the nature of the scatter of the points will give clear indication of the safety margin which can be reasonably expected to cover all eventualities. In Fig. 1, for example, most of the points lie well grouped round the average line, and at a water level L a greatest depth, say, of S would appear reasonably safe. But in Fig. 2 the points are much more scattered, though the average width between the boundary lines is about the same as in Fig. 1. For a given water level L in this case more margin would be allowed, and a greater depth of, say, D would be allowed for.

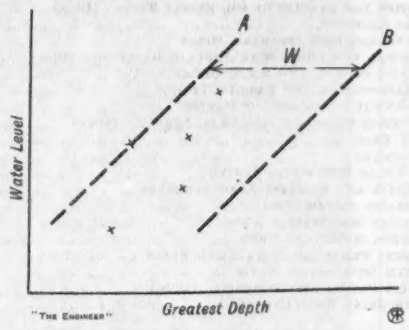


FIG. 5

In this way the directly relevant information may be taken from the sections analysed. But further paths of investigation can be opened up to give assistance if necessary. The greatest depth in each section has been dealt with, and attention can now be turned to the next greatest depth in each section, which can be attacked in precisely the same way. Following that, the next greatest depth but one, and so on. For each, the variability can be summed up by measuring the width of the scatter band as defined by the boundary lines, and if these are plotted in their turn, it is to be expected that they will lie on a continuous curve, and the scatter of these points round such a curve drawn in to fit them best gives further information of value. Here the scatter will be dependent on the number of sections available to a large extent, since the greater the number the truer the position of the boundary lines for each individual depth graph. Observational errors will, however, tend to cancel out, since each point on this plot has the nature of an average. Hence a truer estimate of the width of the scatter band of the greatest depth may possibly be obtained from the mean curve than from the graph of the greatest depths themselves.

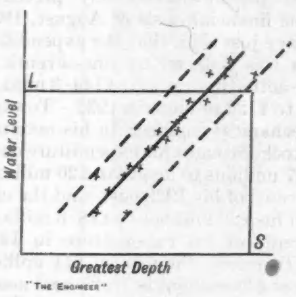


FIG. 1

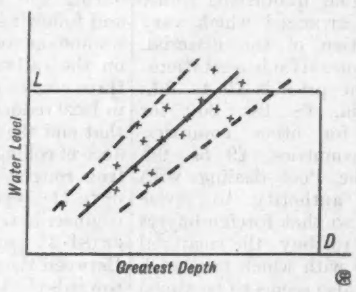


FIG. 2

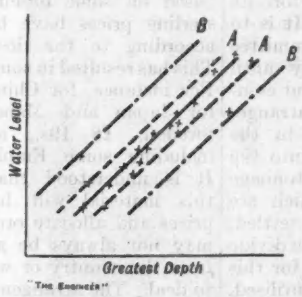


FIG. 3

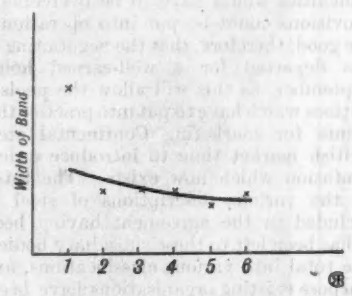


FIG. 4

An example of the utility of this deeper investigation is given in Figs. 3 and 4. Fig. 3 represents the graph of greatest depth against water levels, and it will be seen that it would be difficult to judge from, since there lie two points much further from the general line than the others. This may be due to observational errors, in which case the pair of lines A A might be taken as the boundaries; but, on the other hand, they may be accurate observations of rare extremes, in which case it would be correct to work from the line B B. To throw more light on the problem, Fig. 4 represents a graph of the widths of

the scatter bands for the greatest depth and the next five depths, which gives clear indication that the true width of the band for the greatest depth is less than that found by including the two points mentioned, which are almost certainly due to observational errors.

To go into still further detail, the distance of the upper and lower boundary lines from the general line might be investigated separately by the same procedure as above.

So far only records for the site in question have been considered, but all available records for the river may be analysed in exactly the same way, and it will be found that comparison of the results of such analysis from other sites will give invaluable assistance in determining a sound value for any particular point, in just the same way that the ordinary statistics of level and discharge for several different points on a river will reinforce each other. Such methods as these are particularly valuable when but few sections are available for the desired site, though lack of sufficient information must inevitably be paid for, since although a good estimate can be made of the index of variability, this has to be tacked on to a datum to find the actual figure for the greatest depth likely to occur, for the determination of which only the directly relevant information is applicable. The best way is to draw in only the upper limiting line—that is, the line of least scour—remembering that it must lie at a slope of 1 : 1, when a safe estimate of the lower limit will result by setting off the scatter band width already settled on. Fig. 5 shows an example of this method. Only five sections are available, and the greatest depth points lie as shown.

From these greatest depth points and from information supplied by records of other sites, a scatter band width of W is considered to allow a sufficient margin. First, the upper limit is drawn in as in line A, the width W is set off from it, resulting in the line B as the lower limit, from which the greatest likely scour may be read off. Provided that the width W is safely estimated, this method must lead to a safe value, since although longer records for the site might increase the width of the band, and, hence, move the line A further to the left, it could not move it to the right or decrease it.

Two statistics for examination have been mentioned—the greatest depth and the greatest depth at one particular point, and methods of tackling the first have been discussed. Similar methods will suggest themselves for the second, and other paths for investigation will open themselves in relation to specific inquiries. For example, the average depth in the section may be discussed. The graph of these points when plotted for each section will have rather different characteristics, since the dependence of the width of the river surface on the water level is a disturbing factor, and may cause the general line to be curved so that the horizontal width will vary with the water level. For purpose of comparison between different sites on the same river, an average width, or the width at some equivalent water level, may be used.

Such a width as this, being of an average nature, might prove of great value as a "coefficient of variability" for general purposes, and even if calculated only by the rough methods here suggested, its quotation as an accompaniment to published details of the construction of river works would be a great benefit. Such details lose much of their value because it is impossible to visualise the characteristics of the river bed and compare them with those of any other river except by direct experience, and the general adoption of an accepted criterion would make such publications more widely applicable to the problems of other engineers instead of being, as is apt to be the case, of little use to a designer engaged in similar work on other rivers.

Plotting the Results of Oil Engine Tests.

By E. R. BRIGGS, M. Inst. C.E., M.I. Mech. E.

WHEN plotting the results of oil engine tests it is usual to draw a curve of the consumption in lb. per brake h.p.-hour against the power of the engine. This has the disadvantage that it does not bring out the rating of the engine and does not lend itself readily for purposes of comparison with other tests. Or the total consumption of fuel in lb. per hour is plotted on the engine output. While this is a more useful curve in showing some of the characteristics of the engine, it is even less comparable than the former method, as it does not show any measure of the efficiency, such as the consumption per unit of power.

It is not unnatural when drawing a curve of test results to work on a base expressed in fractions of the load, since the tests are usually specified in this way. This method, while quite convenient for the same make and type of engine, is not suitable for comparative purposes with other makes and types, as it depends entirely upon the rating adopted by the makers, and although an attempt has been made to determine the full load of an oil engine, plotting tests in this way is not very scientific, however good it may be commercially.

There are several interesting points that are worth bringing out when indicating by a diagram the results of engine tests. The difficulty is in simplifying the method of plotting so that one diagram will give most of the information desired. One of the most vexed questions in oil engine work is that of rating. Without wishing to raise a controversy, it may be said that it is certainly convenient to know the mean effective pressure, preferably the brake mean pressure. For ordinary purposes it is required to know the consumption in lb. per b.h.p.-hour. For more accurate purposes the thermal efficiency is desirable; this may be expressed in the usual manner as a ratio of the heat converted into useful work to the heat supplied to the engine. It is sometimes useful to know the heat consumption

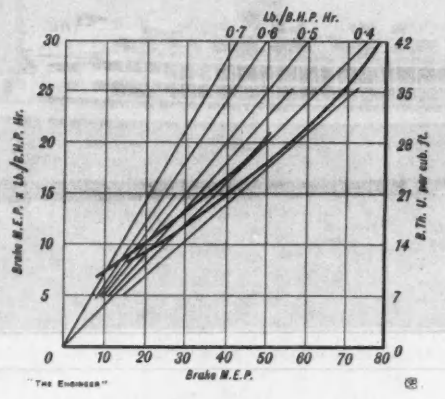


FIG. 1

of the engine in B.Th.U. per b.h.p.-hour, or in B.Th.U. per cubic foot of working stroke.

It is not difficult to show quite a number of these results from a single curve. The most important thing is the scale used for the base. It is not without significance that Willans, in the tests from which the Willans Law was deduced, plotted his results on the mean effective pressure referred to the low-pressure cylinder. Although the Willans Law does not apply to oil engines, there are many advantages in following this practice. Owing to the difficulty, even in medium-speed engines, in obtaining the i.h.p., and for reasons of rating, it is preferable that the brake mean effective pressure be used. This basis for comparison is probably the best there is, since the shape of the curve in relation to the brake mean effective pressure shows up more clearly the characteristics of an engine.

Such a method of plotting is shown in Fig. 1,

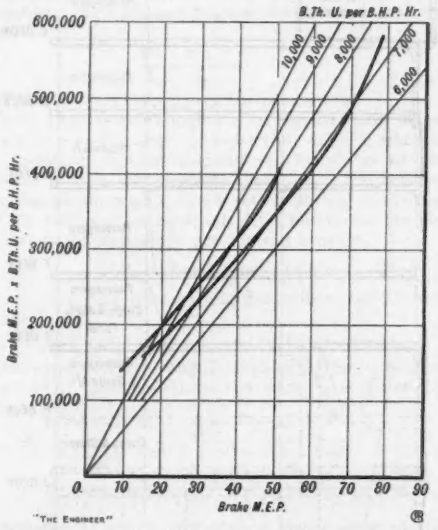


FIG. 2

where the ordinates are values of the brake mean effective pressure multiplied by the consumption in lb. per b.h.p.-hour. The shape of the curve is, therefore, exactly the same, to a different scale, to what would be obtained in a constant-speed engine, by plotting the total fuel against the b.h.p. output. But whereas the latter has no comparative value, Fig. 1 enables direct comparison to be made with any test plotted in this way. Two diagrams may be combined into one by drawing radial lines as shown of the fuel used in lb. per b.h.p.-hour. As the consumption is directly proportional to the scale of ordinates, interpolations must be read on a vertical line. Two curves are shown in this figure, both from tests made by Mr. Tookey, and published in *Gas and Oil Power* for April, 1934. The lower curve is of a National four-stroke, six-cylinder engine of 630 b.h.p. at 300 r.p.m.; the upper of a four-cylinder Petter Atomic of 195 b.h.p. at 375 r.p.m., but the tests were taken at 330 r.p.m.

A little arithmetic will show that:

$$p \cdot w \cdot C = 13{,}750 \cdot h,$$

where p = brake mean effective pressure.
w = lb. of fuel per b.h.p.-hour.
C = calorific value of oil.
h = B.Th.U. per cubic foot displacement.

Taking C at 19,250 gross value, which is substantially that of the fuel used in the two cases, gives $h = 1{\cdot}4\,p.w$. In other words, if the figures of the left-hand scale of Fig. 1 be multiplied by 1·4, as shown on the right-hand scale, it is possible to read off direct the heat consumption in B.Th.U. per cubic foot of working stroke.

Instead of the radial lines reading the fuel consumption in lb. per b.h.p.-hour, they may be drawn in terms of B.Th.U. per b.h.p.-hour. But the diagram is then special for one calorific value of fuel only, unless the scale of ordinates is one of brake mean effective pressure multiplied by B.Th.U. per b.h.p.-hour, as in Fig. 2, which gives the heat consumption values of the two engines referred to in connection with Fig. 1. Fig. 2 is quite general and truly comparative, but as users do not buy fuel oil by the therm, whatever the gas people may do, it is more useful to show results as in Fig. 1.

Fig. 3 is a modification of Fig. 1 so far as the radial lines are concerned which give the percentage

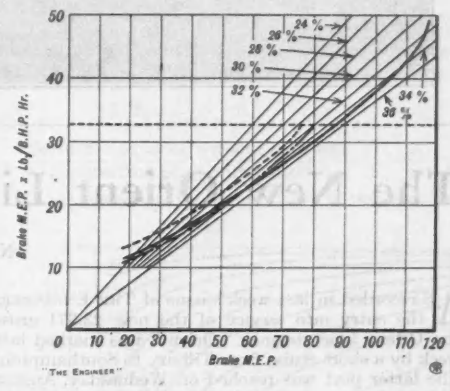


FIG. 3

thermal efficiencies. In this example, the tests have been taken from the fourth, fifth, and sixth Reports of the Marine Oil-Engine Trials Committee. The full line extending beyond 110 lb. brake mean effective pressure is of the Scott six-cylinder, four-stroke, S.A. engine, fitted with Büchi supercharger, and forms the subject of the sixth Report. The upper plain dotted curve gives the results of the Hawthorn, Leslie-Werkspoor, four-stroke, S.A. engine from the fifth Report. The chain-dotted curve is of the Palmer-Cammellaird-Fullagar six-cylinder, two-stroke, opposed-piston engine from the fourth Report. All the engines have air injection. The average gross calorific values of the fuels are 19,500 B.Th.U. for the Scott engine, 19,200 for the Werkspoor, and 19,120 for the Fullagar. For the purposes of the diagram, 19,250 has been taken.

Since the efficiency

$$e = \frac{2545}{w \cdot C}$$

by substituting C = 19,250,

$$e = \frac{0{\cdot}132}{p \cdot w} \cdot p$$

it is convenient to take a value of $p.w$ that divides evenly into 0·132, such as 33, then $e = 0{\cdot}004\,p$, and values of e can be marked off along the line 33, shown dotted in Fig. 3. It should be noted that interpolations between radial lines must be made horizontally, instead of vertically, as in Figs. 1 and 2.

Standard printed sheets can be prepared as for Fig. 1, but without the right-hand scale, or Fig. 2, in which the radial lines could either be B.Th.U. per b.h.p.-hour or efficiencies. Such diagrams would be correct for all calorific values.

BOOKS RECEIVED.

Britain's Fighting Fleets. By A. G. Vercoe. London: Percival Marshall and Co., Ltd., 13–16, Fisher-street, W.C.1. Price 2s. 6d. net.

Descriptive Mathematics. By J. Maclean, M.A., B.Sc. London: Macmillan and Co., Ltd., St. Martin's-street, W.C.2. Price Rupees 2·8.

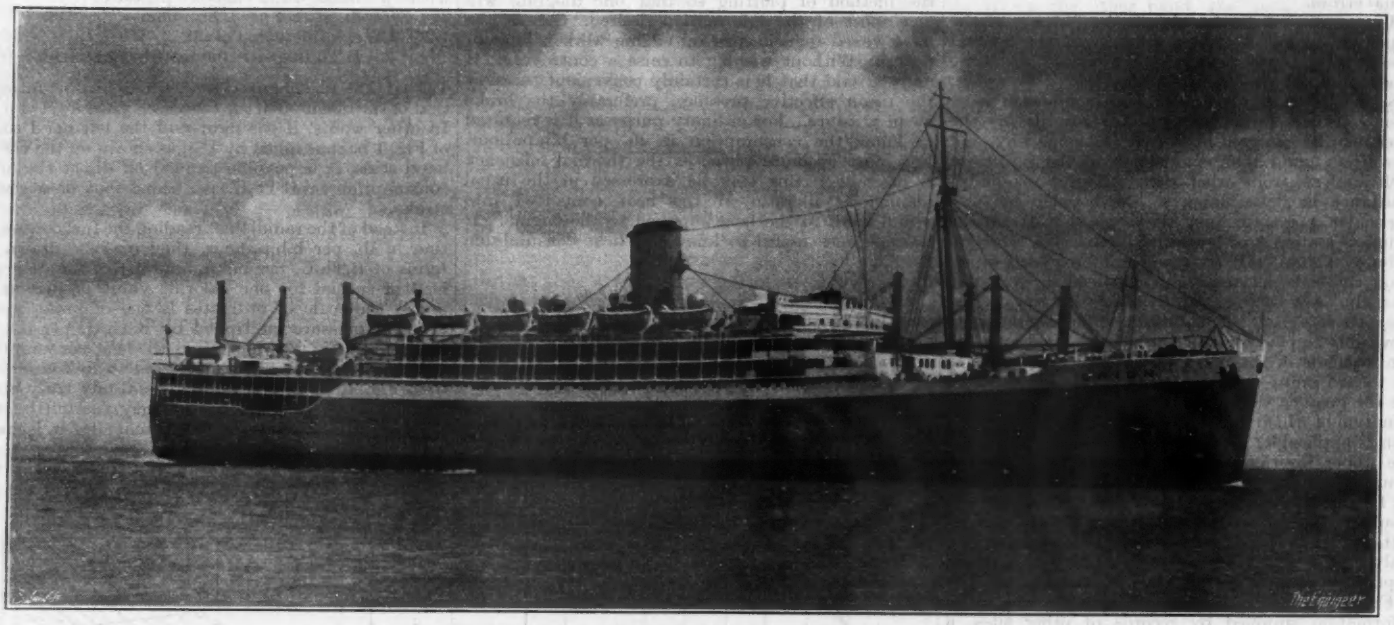
Alternating Current Practice. By C. H. Claude Cooke. London: Crosby Lockwood and Son, Ltd., Stationers' Hall-court, E.C.4. Price 9s. 6d. net.

Machine Drawing for the Use of Engineering Students. By the late T. Jones, M.I. Mech. E., and T. G. Jones, M.Sc. Manchester: John Heywood, Ltd., Deansgate. Price 6s. net.

Molybdenum Steels: Their Manufacture and Application. Prepared by J. L. F. Vogel, M.I.E.E., M.I.M.M., and W. F. Rowden. Widnes: High Speed Steel Alloys, Ltd., Ditton-road. Price 5s. net.

THE ORIENT LINE STEAMER "ORION"

VICKERS-ARMSTRONGS, LTD., BARROW-IN-FURNESS, BUILDERS



The New Orient Line Steamer "Orion."

No. I.

As recorded in last week's issue of THE ENGINEER, the entry into service of the new 23,371 gross ton Orient Line steamer "Orion" was marked last week by a short cruise from Tilbury to Southampton. The latter port was reached on Wednesday, August 14th, and the same day the liner sailed on a twenty-four-day pleasure cruise to the Mediterranean, before taking up her regular scheduled service to Australia. Her maiden voyage to Australia will be made from Tilbury on Saturday, September 28th, Brisbane being reached on Monday, November 11th. Three days later the "Orion" will start on her return voyage, reaching Tilbury on Thursday, January 2nd. She is a twin-screw geared turbine steamer, designed for the carriage of passengers, mails, and cargo. It may be recalled that the ship was launched at the Barrow-in-Furness yard of Vickers-Armstrongs, Ltd., on Friday, December 7th, 1934, the releasing of the hull from the launching ways being accomplished by means of a wireless impulse from Brisbane, Australia, transmitted by His Royal Highness the Duke of Gloucester during his recent Australian tour. A view of the liner on trial is reproduced in the engraving above.

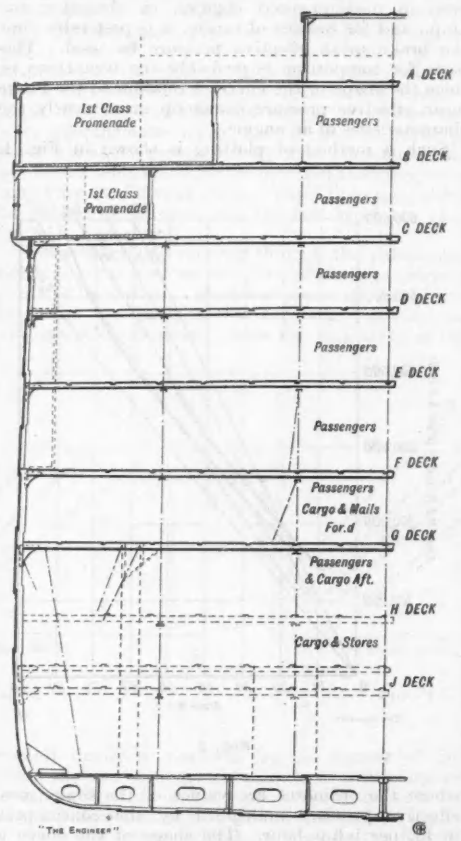
The "Orion" was constructed under the survey and supervision of Lloyd's Register of Shipping for the highest class certificate and also conforms to the latest rules and regulations of the Board of Trade. In the table below we give her principal dimensions, &c.:—

Length overall	665ft.
Length between perpendiculars	630ft.
Breadth overall	84ft.
Breadth moulded	82ft.
Depth moulded to "F" deck	38ft.
Depth moulded to "E" deck	47ft. 6in.
Displacement tonnage	28,400
Gross register tonnage	23,371
Draught	30ft.
Total shaft horse-power	24,000
Designed service speed	21 knots
First-class passengers	486
Tourist class passengers	653
Officers and crew	466

Hull Design and Safety Equipment.

As shown by the half mid-section, there are eight decks, including the promenade decks, and, with the exception of the lowermost deck, all are intended for the use of passengers. Attention may be drawn to the handsome external appearance of the ship, which is enhanced by the adoption of corn colour instead of black for the hull, and green in place of red boot-topping. The use of a single funnel is made possible by the adoption of high-pressure oil fuel boilers, and there is a single forward mast. It is of interest to mention that the Board of Trade regulations require a ship to carry one light at the foremast head, but that a general usage to carry one light at each masthead has grown up with two-masted ships. This usage has, in the case of the "Orion," been met by carrying one light on the forward stay and the other at the masthead.

With regard to hull subdivision, the latest rules of the International Convention for Safety of Life at Sea have been fully complied with. The hull has been subdivided into a series of water-tight compartments up to "F" deck by twelve transverse water-tight bulkheads, with a minimum of water-tight doors. The continuous double bottom of the ship is carried from the collision bulkhead forward right aft to the shaft tunnels. In accordance with modern practice, the double bottom is divided transversely and longitudinally into a number of tanks, in which supplies of fresh water, boiler feed water, water ballast, and oil fuel are carried. From the forward bunker to the after end of the engine-room there is a double skin up to the water line, thereby providing a maximum margin for safety at sea.



HALF MID-SECTION

Other safety equipment includes twenty-four lifeboats, including two motor lifeboats, which are supported in davits of the latest Welin-Maclachlan type, arranged on "A" deck, and designed to accommodate the whole of the passengers and crew, should necessity arise. No expense has been spared to make the ship fireproof, and to provide her with the fullest and latest precautionary measures for preventing and detecting fires. Besides smoke-detection apparatus by the Walter Kidde Company, Ltd., and Pyrene, Minimax, and Foamite, extinguishing plant, there is a complete arrangement of Grinnell sprinklers, designed and fitted by Mather and Platt, Ltd., of Park Works, Manchester, which is the largest installation of its kind yet installed on a modern liner. The system is so designed that in a normal way the sprinklers are under air pressure, but as soon as a fire takes place the fire pumps are automatically started up and supply high-pressure water to the system. Other precautions against fire include the painting of all wooden grounds and linings in the passenger accommodation with fire-resisting paint, and the making of all lift shafts fireproof.

Passenger Accommodation.

The whole of the first-class passengers—some 486 persons—are carried in 315 single and two-berth cabins, arranged on "C," "D," and "E" decks, also forward of the dining-room on "F" deck. The decoration, both of the cabins and public rooms, was carried out by artists under the direction of Mr. Brian O'Rorke, who has adopted an original, dignified, modern scheme of treatment. He has avoided any attempt at period styles, and with the aid of Australian woods, glass, stainless steel, and rugs and carpets of special design, has produced a unified scheme which, alike in first-class or tourist sections, strikes an entirely new note and is very pleasing. On page 194, we show a view in the first-class dining saloon. This room has a length of 82ft. and a width of 72ft., and is designed to seat about 250 persons at small tables. In the adjoining foyer there is room for forty more persons, while a special dining saloon for children is intended to be used for private parties when occasion demands. The main public rooms are on "B" deck. Forward on this deck is the lounge, and walking aft one passes through the library and the galleries into a covered dancing space, which is also used for cinematograph performances. Further aft is the café, with its open-air verandah attached.

For many years a feature of Orient Line ships has been the generous deck space allowed for passengers. The increased beam of the "Orion" makes her outstanding in this respect. As shown on page 194, the sports and games space on "A" deck is very large, and gives an area 200ft. long by 82ft. wide, unbroken except for the funnel uptakes, ventilating cowls, and outlets, and the engine-room skylights. On "C" deck there is a swimming pool for first-class passengers. Attention may be called to the metal slats at either end of the bath which prevent splashing. As may be seen from the engraving, the shelter given by the dressing-rooms and the adjacent tavern or cocktail bar will make this part of the ship very popular. On "C" deck there is a nursery for children, comprising closed and open-air spaces.

The tourist passengers have similar, though naturally not quite such elaborate, provisions made for their comfort and amusement. The tourist cabins are on "F," "G," and "H" decks, and comprise 285 cabins for 653 passengers. On "F" deck there is a large tourist dining saloon, 82ft. in length and 68ft. wide, with a lounge situated immediately aft of the saloon, and a café on "E" deck, 68ft. long by 44ft. wide, a dancing space being provided at the after end. We show on page 194 the open-air swimming bath for tourist passengers, which is arranged on "C" deck immediately aft

of the first-class pool. A dividing screen is so arranged that these two open-air spaces can be thrown together to make one space when desired.

SOME AUXILIARY MACHINERY.

The deck fittings and auxiliary machinery include some new features. For the first-class cabins on the ship's side close upon one hundred "Orient" pattern spring-balanced, pressure-tight windows, with hinged ventilators, have been fitted instead of ordinary port-holes and lights. These windows were supplied by J. Stone and Co., Ltd., of Deptford, which firm also supplied other windows and a Stone-Empson patented emulsifier designed for producing milk, cream, or ice cream mixture at the rate of 60 gallons per hour. For the first-class dining saloon an air-conditioning plant has been provided, designed by the Carrier Engineering Company, Ltd., of London.

The cargo arrangements include provision for carrying insulated cargo in Nos. 1, 2, and 3 holds, and in the 'tween deck spaces forward, the refrigerating arrangements being carried out on the CO_2 air-cooled system. General cargo is carried in Nos. 4, 5, and 6 lower holds aft. The cargo is worked by derricks served by 3-ton and 5-ton Napier electric winches, and two 10-ton and one 20-ton derricks are fitted to deal with heavy loads. The electric windlass and the warping capstans were supplied by Napier Brothers, Ltd., of Glasgow, and are fitted with electric motors operating on the Gilbert Austin constant-current principle. The steering gear is of the electro-hydraulic type, and is controlled by telemotor from the bridge, mechanical controls being also fitted in "C" deck aft. The gear comprises Hastie pumps with Brown Brothers' steering gear and helm indicator.

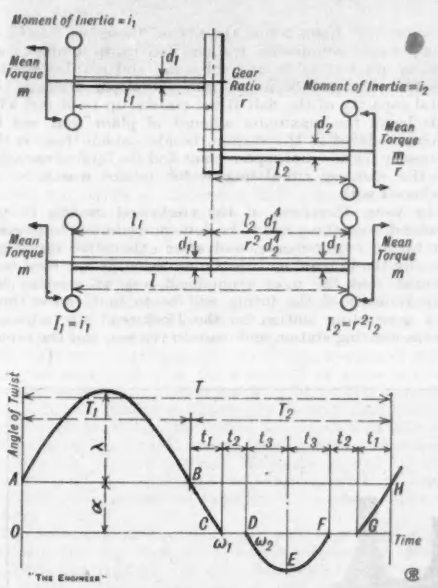
(To be continued.)

Torsional Vibrations with Angular Backlash

By W. A. TUPLIN, M.Sc.

IN investigating the torsional vibration characteristics of a drive which incorporates gearing, the usual procedure is to replace it, for calculation purposes, by an "equivalent dynamical system" in which all shafts run at the same speed, the lengths of the shafts and the moments of inertia of the rotors being determined so as to give the same dynamical effects as the actual ones.

This simple procedure neglects the effect of backlash between the teeth of mating gears. So long as the torque transmitted by the gears does not change sign, no error is involved in substituting the "equivalent system." If the torque does change sign, however, the gears must lose contact on one set of mating tooth flanks, and must undergo relative angular movement of an amount represented by the backlash before contact is established on the other set of flanks. During the transition period the torque in the shafts must be zero (if the inertia of the gears themselves be neglected), whereas in a normal ungeared system zero torque occurs only instantaneously. The natural frequency of a geared drive therefore tends to be lower than that of the "equivalent dynamical system" by an amount depending on the backlash, and, it will be shown, the amplitude of vibration and the mean torque transmitted.



FIGS. 1 AND 2

In Fig. 1 the lower diagram shows the equivalent dynamical system corresponding to the geared drive indicated in the upper diagram. The moment of inertia of the gears is assumed small compared with those of the other rotors in the system.

Let Angle of twist produced in shaft by mean torque .. .. = α
Amplitude of vibratory angle of twist = λ
Angular backlash .. .. = δ
Spring constant of shaft (the torque corresponding to unit angle of twist) .. .. = k

The transmission of the constant mean torque through the shaft connecting the rotors does not affect the natural frequency of the system for torsional vibration. Apart from backlash, the variation of angle of twist with time would be represented by a sine curve of mean height α corresponding to the expression

$$\theta = \alpha + \lambda \sin n t,$$

where $n = 2\pi \times$ (natural frequency in cycles per unit time)

$$= \sqrt{\left[\frac{k}{I_1} + \frac{k}{I_2}\right]}$$

time being measured from an instant at which $\theta = \alpha$ and $\frac{d\theta}{dt} = n\lambda$.

This applies in the actual system so long as the gross torque does not change sign.

The conditions during a natural vibration in a system having backlash are indicated in Fig. 2. From A to C the angle of twist is positive and the variation of angle with time is represented by the sine curve

$$\theta = \alpha + \lambda \sin n t.$$

The time T_1 is half the periodic time for such a harmonic vibration, *i.e.*, π/n.

At the instant C the angle of twist is zero, the time (measured from O) is $(\pi/n) + t_1$, and therefore

$$0 = \alpha + \lambda \sin n [(\pi/n) + t_1],$$

$$\text{or } t_1 = \frac{1}{n} \sin^{-1} \frac{\alpha}{\lambda}$$

The relative angular velocity of the rotors at any instant between A and C is given by $\frac{d\theta}{dt} = n\lambda \cos n t$, and therefore

$$\omega_1 = \text{Rel. ang. velocity at C} = n\lambda \cos\left(\pi + \sin^{-1}\frac{\alpha}{\lambda}\right)$$
$$= n\lambda \sqrt{[1 - (\alpha/\lambda)^2]} = n \sqrt{(\lambda^2 - \alpha^2)},$$

suppressing a negative sign which is taken into account in the next paragraph but one.

From C to D there is no contact between the gears and therefore no torque in the shaft connecting the two rotors. During that period rotor No. 1 is subjected to the mean torque $k\alpha$ in one direction and rotor No. 2 is subjected to an equal torque in the other direction. The relative angular acceleration is therefore

$$\frac{k\alpha}{I_1} + \frac{k\alpha}{I_2} = n^2 \alpha$$

and this applies throughout the period C D.

This angular acceleration is in the direction which tends to give the angle of twist the value α, whereas the relative angular velocity of the rotors at the instant C is in the opposite direction. The relative angular displacement of the rotors during the period C D is the angular backlash δ. Therefore from the equations of uniformly accelerated motion,

$$\omega_2^2 - \omega_1^2 = 2(-n^2\alpha)\delta,$$

where ω_2 is the relative angular velocity at D, and hence

$$\omega_2 = \sqrt{(\omega_1^2 - 2n^2\alpha\delta)} = n\sqrt{(\lambda^2 - \alpha^2 - 2\alpha\delta)}.$$

The mean relative angular velocity from C to D is $\frac{1}{2}(\omega_1 + \omega_2)$, and therefore the time t_2 is given by $\frac{1}{2}(\omega_1 + \omega_2)\, t_2 = \delta$, or

$$t_2 = \frac{2\delta}{n\left[\sqrt{(\lambda^2 - \alpha^2)} + \sqrt{(\lambda^2 - \alpha^2 - 2\alpha\delta)}\right]}$$
$$= \frac{1}{n} \frac{2\delta/\alpha}{\sqrt{[(\lambda/\alpha)^2 - 1]} + \sqrt{[(\lambda/\alpha)^2 - 1 - 2\delta/\alpha]}}$$

Between D and E the relative acceleration of the rotors is due to the opposing mean torques and to the twist in the connecting shaft. The former is equal to $-n^2\alpha$ and the latter to $-n^2\theta$, where θ is the angle of twist.

Hence

$$\frac{d^2\theta}{dt^2} = -n^2(\alpha + \theta), \text{ or, since } \alpha \text{ is constant,}$$

$$\frac{d^2(\alpha+\theta)}{dt^2} = -n^2(\alpha+\theta).$$

The solution to this equation is

$$\alpha + \theta = A \sin n t + B \cos n t,$$

where A and B are arbitrary constants.

Therefore

$$\frac{d\theta}{dt} = n(A \cos n t - B \sin n t)$$

and

$$\frac{d^2\theta}{dt^2} = -n^2(A \sin n t + B \cos n t).$$

At the instant D the relative angular velocity is ω_2, and therefore, measuring time from that instant, $\frac{d\theta}{dt} = \omega_2$, when $t = 0$.

i.e., $\omega_2 = n(A \cos 0 - B \sin 0)$, whence $A = \omega_2/n$.

At the instant $t = 0$, $\theta = 0$, and therefore the relative angular acceleration is $-n^2\alpha$. Consequently,

$$-n^2\alpha = -n^2[(\omega_2/n)\sin 0 + B\cos 0], \text{ whence } B = \alpha.$$

The equation representing the variation of θ with time is therefore

$$\theta = (\omega_2/n)\sin n t + \alpha \cos n t - \alpha$$

and

$$\frac{d\theta}{dt} = \omega_2 \cos n t - n\alpha \sin n t.$$

At the instant E the relative angular velocity is zero, and therefore $0 = \omega_2 \cos n t_3 - n\alpha \sin n t_3$, whence $\tan n t_3 = \omega_2/n\alpha$, and

$$t_3 = \frac{1}{n}\tan^{-1}\frac{\omega_2}{n\alpha} = \frac{1}{n}\tan^{-1}[(\lambda/\alpha)^2 - 1 - 2\delta/\alpha].$$

From symmetry, periods E F, F G, and G H are respectively equal to t_3, t_2, and t_1.

Hence, $T_2 = 2(t_1 + t_2 + t_3)$

$$= \frac{2}{n}\left\{\sin^{-1}\frac{\alpha}{\lambda} + \frac{2\delta/\alpha}{\sqrt{[(\lambda/\alpha)^2 - 1]} + \sqrt{[(\lambda/\alpha)^2 - 1 - 2\delta/\alpha]}} + \tan^{-1}[(\lambda/\alpha)^2 - 1 - 2\delta/\alpha]\right\}$$
$$= \frac{2}{n}K \text{ (say).}$$

The periodic time is therefore

$$T = T_1 + T_2 = \frac{\pi}{n} + \frac{2}{n}K.$$

Denoting the periodic time of the same system without backlash by T_o, we have

$$T/T_o = \left(\frac{\pi}{n} + \frac{2}{n}K\right)/2\frac{\pi}{n}, \text{ or}$$

$$\frac{1}{R} = \frac{\text{Natural frequency without backlash}}{\text{Natural frequency with backlash}} = \frac{T}{T_o} = \frac{K}{\pi} + \frac{1}{2}.$$

If the expression $(\lambda/\alpha)^2 - 1 - 2\delta/\alpha$ is negative, ω_2 is imaginary, and the interpretation is that the conditions assumed for period D F do not arise. This occurs if the angular backlash is so great that the relative angular velocity in the period immediately after the break of tooth contact becomes zero before contact can be established on the other set of tooth flanks. In that event, the relative angular velocity changes sign, and contact is re-established on the original set of tooth flanks. The point D coincides with G and the interval C D is the time required for the relative angular velocity to change from ω_1 to $-\omega_1$, *i.e.*,

$$\frac{-2\omega_1}{-n^2\alpha} = \frac{2n\sqrt{[\lambda^2 - \alpha^2]}}{n^2\alpha} = \frac{2}{n}\sqrt{\left[\left(\frac{\lambda}{\alpha}\right)^2 - 1\right]}$$

Therefore, if $(\lambda/\alpha)^2 - 1 - 2\delta/\alpha$ is zero or negative,

$$T_2 = \frac{2}{n}\left\{\sin^{-1}\frac{\alpha}{\lambda} + \sqrt{\left[\left(\frac{\lambda}{\alpha}\right)^2 - 1\right]}\right\}$$

and

$$K = \sin^{-1}\frac{\alpha}{\lambda} + \sqrt{\left[\left(\frac{\lambda}{\alpha}\right)^2 - 1\right]}$$

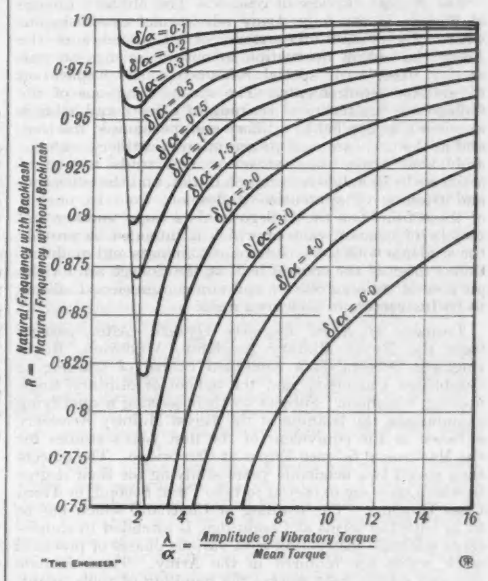


FIG. 3.

The values of R are plotted in Fig. 3 for a range of values of δ/α and λ/α.

In a drive which has no angular backlash, each critical speed lies near the middle of a range of speed in which excessive torsional vibration occurs. If there is backlash the critical speed itself has no single value, but lies within a speed range corresponding to the range of natural frequency determined by the value of δ/α. As the amplitude of vibration increases, the critical speed rises from its lower limit to its upper limit. Thus, the effect of the backlash is to widen each range of speed within which severe vibration occurs.

In a geared drive it is important that there should be no cyclic reversal of torque on the gears at any

running speed. Such a condition leads to noise and to excessive wear of the gear teeth because of the hammering action to which they are subjected. The stresses set up in the teeth when contact is made on either set of tooth flanks are dependent on the inertia of the gears themselves and the relative angular velocity with which the impact occurs. The inertia of the other rotating masses is (usually) less important because of the torsional elasticity of the intervening shafts.

It will be seen that in a geared drive subjected to cyclic fluctuation of torque, such as is produced by an internal combustion engine, the backlash should be minimised, first, with the object of narrowing the critical speed ranges, and, secondly, to reduce the tooth stresses due to impact associated with cyclic torque reversal which may be unavoidable at certain speeds attained momentarily when starting up or shutting down the plant.

The Training of R.E. and R.C.S. Officers.

In a paragraph in our issue of June 14th recording the holding of an "At Home" at the Military College of Science, Woolwich, we said that the College is primarily devoted to the scientific instruction of officers of the Royal Artillery, Royal Engineers, and Royal Corps of Signals and that it fulfils for the Army much the same function as Greenwich College fulfils for the Navy. It has been represented to us that while a certain number of Royal Engineer and Royal Corps of Signals officers do at times receive scientific training at the College, our paragraph is capable of being misinterpreted as implying that attendance at the College is a normal part of the training of the general body of officers of these two corps. In order to clarify the position we append a brief note which will make the function of the College plain and add to it notes explaining the general scientific instruction of Royal Engineer and Royal Corps of Signals officers.

The Military College of Science.—The Military College of Science is the only Army educational establishment where officers and other ranks of all branches of the Army can obtain instruction in natural science on university lines, with special reference to its application to military requirements. The special functions of the College are the technical training of officers and soldiers in science, as applied to artillery and mechanised traction, and in the use, care, and preservation of artillery material and small arms, the instruction and trade testing of artificers to be employed on such duties, and the education and training of apprentice tradesmen, &c. In pursuit of these functions the College holds a large number and variety of courses, each of which is intended to provide the students with some definite attainments and qualifications; most of the courses held at the College are for the purpose of training officers and non-commissioned officers to be Instructors in their own units.

Training of Royal Engineer Officers.—After passing from the Royal Military Academy, Woolwich, Royal Engineer Officers do a combined course of training at Cambridge University and the School of Military Engineering, Chatham. Subject to their passing a qualifying examination the training at the Royal Military Academy is taken as the equivalent of the first year's studies for the Mechanical Science Tripos at Cambridge. The officers then spend two academic years studying for their degree in which they are expected to take First, Second, or Third Class Honours. The training at Chatham, which has to fit in with the terms at Cambridge, is intended to supplement scientific instruction with various phases of practical work which are required in the Army. These include military duties, field works, the handling of tools, plant, &c., which form part of the military equipment of R.E. units, survey, the application of building principles to hutted construction such as is likely to be used in the field, and practical electrical installations, including special types of fittings used on War Department work in both permanent and temporary construction. Those officers subsequently selected for special employment on railway, electrical, and mechanical engineering go to civil railway companies or manufacturing firms to gain practical experience in these branches.

Training of Royal Corps of Signals Officers.—After passing from the Royal Military Academy, Woolwich, Royal Signals Officers do a course of a year and a half at the School of Signals, Catterick. A selected proportion of them subsequently go to Cambridge for two years to study for a Degree in Mechanical Science. The training at Catterick covers all branches of telegraph and telephone engineering, both by line and by wireless, in their special application to conditions in the field, in addition to visual signalling and the military duties of an officer. The training at Cambridge is for those officers who are likely to prove suitable later on for special technical appointments, such as those connected with wireless research and design.

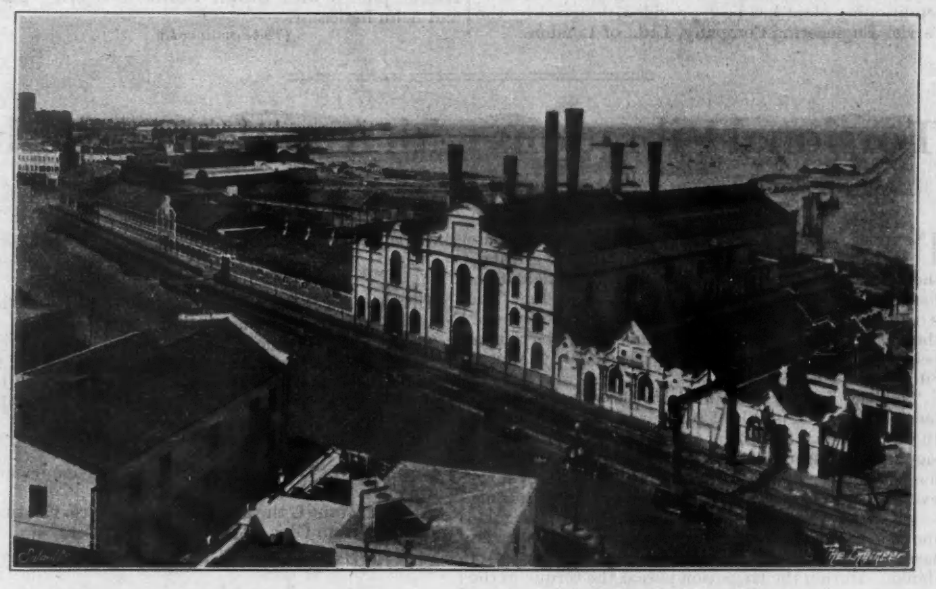
According to the advance summary issued by the U.S. Bureau of Mines, the mineral production of the United States in 1934, including metals, non-metals, and fuels, was valued at 3350 million dollars, an increase of 31 per cent. from 2,555,100,000 dollars in 1933. This advance in total value reflected not only increased output, but also higher unit prices, which resulted in part from provisions of codes of fair competition under which virtually all branches of the mineral industry were operating to some extent during 1934. Production of practically all major mineral commodities increased in 1934; outstanding examples were coal, gold, silver, natural gas, cement, and crushed stone. Prices likewise increased, especially for silver, gold, pig iron, copper, petroleum, bituminous coal, and cement.

Big Electricity Scheme for Cape Town.

A big power station with an ultimate capacity of 200,000 kW is to be erected by the Cape Town Council to meet the requirements of that body, and of the Electricity Supply Commission, in the Cape area.

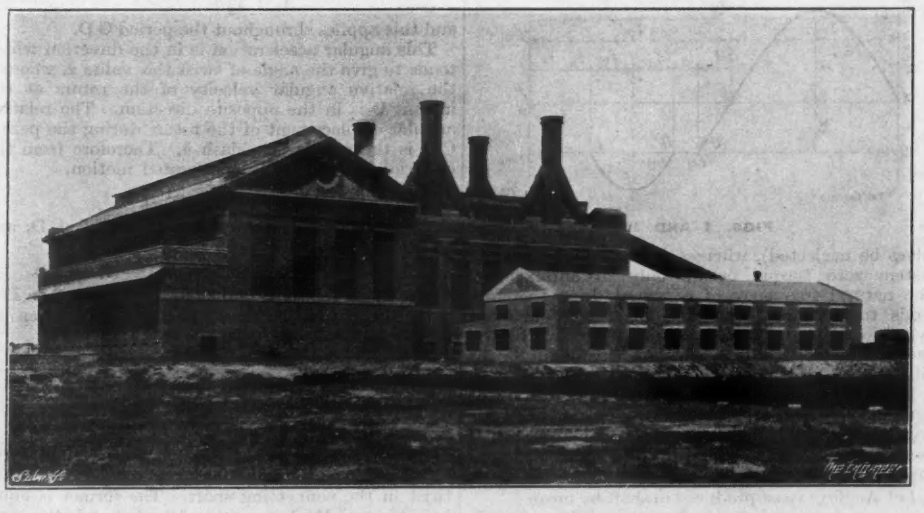
The Cape Town electricity undertaking provides an excellent example of the enormous expansion which has taken place in the Union in the use of electricity, especially in the last five years. The first Cape Town power station was opened in 1895, and the equipment consisted of two 150 kW sets. It was situated near the Molteno reservoir and at a considerable height above the main portions of the City. By 1904 there had been several additions, and it was recognised that the cost of haulage of coal and the amount of circulating water required, rendered it imperative that a more suitable site be selected. Accordingly, in that year, a new power station was built alongside the Dock-road, and in close proximity to the railway and to the sea, and this was equipped with machines giving 1850 kW. Very soon further power had to be provided, and the demand still continued to grow, and at an accelerated pace, until by the end of 1930 the generating plant consisted of three Metropolitan-Vickers turbo-alternator sets of 7500 kW normal full-load rating each, and two B.T.H. turbo-alternator sets of 3000 kW normal full-load rating each. The steam-raising plant, comprised two boilers, each of 17,500 lb. steam per hour nominal evaporative capacity; two boilers, each of 32,000 lb. steam per hour; four boilers, each of 35,000 lb. steam per hour, and two boilers, each of 50,000 lb. steam per hour. Already the necessity for further power provision was pressing, but, fortunately, the Electricity Supply Commission had erected at Salt River, about two miles away, a power station to provide power for the electrically operated trains on the Cape Town Southern Suburbs Railway system, the Salt River workshops, certain private industrial concerns in country towns within a radius of 30–40 miles, as well as supplies to consumers in and around a number of outlying townships. Accordingly, an arrangement was come to by which that power station operated in parallel with the Cape Town Dock-road station, and the two stations were of mutual assistance to each other in dealing with abnormal loads and when breakdowns occurred at either station.

So rapidly, however, did demand increase that in 1932 an agreement was entered into between the Commission and the Council by which it was agreed to pool the generating plant resources of the two undertakings for the joint benefit of both parties' consumers. As more power was still required to meet the increasing load, it was decided that the most economical course would be to install the additional plant at the Salt River power station. The existing plant there consisted of three 10,000 kW Howden-Zoelly single-cylinder turbines with English Electric alternators, generating at 11,000 volts, and four Babcock and Wilcox water-tube boilers with a normal rating of 60,000 lb. per hour and a working pressure of 270 lb. per square inch. The additional plant, called the 1932–1933 extensions, comprised two 20,000 kW (C M R) turbo-alternators generating at 33,000 volts, and four 131,000 lb. per hour (C M R) boilers working at a pressure of 425 lb. per square inch. The steam system of the new boilers was linked up to that of the original boilers, through a reducing valve, and the new generating sets were coupled to the existing system through the 11 kV/33 kV, 6000 kVA transformers, of the step-up sub-station. Even before the first of these two machines was put into commission, the load had grown so much that the second had to be hurried along and a third similar machine has just been put into operation, bringing the total capacity of the Salt River station up to 90,000 kW, this being the maximum amount of plant that can be accommodated in the station, besides which there is the necessity for adequate spare plant and the limited capacity of the existing circulating water intake works to be reckoned with.



Dock Road Power Station

In view, therefore, of the continued growth in the demand, something had to be done immediately to provide for future requirements, and after exhaustive investigation by the Council and the Commission, it has been considered that the most economical way of meeting the requirements of the future will be to build an entirely new generating station on the Dock-road site adjacent to the existing station and close to the sea, and the report of Mr. George H. Swingler, city electrical engineer and manager of the pooled stations, has been adopted after the consulting engineers, Messrs. Merz and McLellan, had reported emphatically in favour of the recommendations which he made. These recommendations were for a new station planned in such a way as to be capable of systematic extension to an ultimate capacity of 200,000, beginning with two machines of 40,000 kW each, this being the largest size of high-efficiency turbo-alternators which can be economically constructed for a speed of 3000 r.p.m. The boilers are to be designed for a pressure of 600 lb. per square inch and a temperature of 800 deg. Fah.

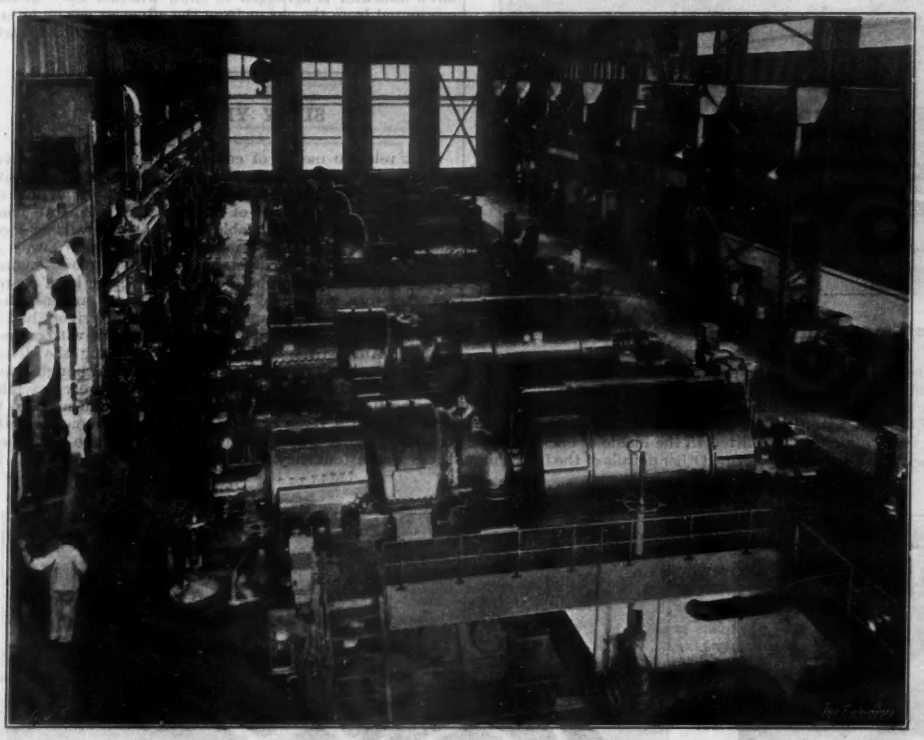


Salt River Power Station

At the meeting on June 11th, the enrolled property owners unanimously sanctioned the expenditure of £1,850,000 for this first stage, the items making it up being: land and buildings, £646,500; machinery, £1,040,500, and engineering and contingencies, £163,000. When

the final stage of extension is reached, with the five 40,000 kW machines installed and the necessary boiler power, &c., the total cost will, it is estimated, have amounted to £3,500,000. Up to the present, the expenditure on the electricity undertaking has amounted to £1,750,000, and it has been an exceedingly reproductive outlay, for the report of the city electrical engineer for the year 1933 states that for the fourth successive year a contribution of £50,000 was made from the revenue of the Electricity Department to the relief of general rates, bringing the total amount contributed to general rates from 1912 up to £558,396 at the end of 1933, representing nearly 33 per cent. of the total loan indebtedness on the electricity undertaking.

The following information may be of interest. In 1924 the total units sold was 27,767,150; for the year 1933



INTERIOR OF SALT RIVER POWER STATION

the total was 105,494,806. In 1924 the number of consumers was 16,974, at the end of 1933 it had increased to 35,497, and at the present day there are about 40,000. During the last four years the sale of electricity has doubled, and 7400 new consumers have been connected, and to-day there are 14,000 electric cookers on the Corporation's system in addition to a large number of refrigerators, water heaters, and other domestic appliances, all having been sold and installed in less than five years since the municipal hire purchase scheme began, and Mr. Swingler does not foresee any falling off in an average increase of 2000 new customers each year for a number of years, a conservative estimate for each stove being 5 h.p. The demand for electricity from the Electricity Supply Commission in the rural areas and for industrial purposes is also on the increase from such centres as the towns of Paarl, Stellenbosch, Somerset West, Malmesbury, and so on. The whole of the Cape area is therefore involved when considering the generating capacity of the power stations at Cape Town.

The total cost of electricity per unit sold is given as 1·0780d. for the year 1933, compared with 1·1920d. for 1932, and 1·3238d. for 1931, and is probably a shade less to-day. The average cost of coal delivered in the bunkers of the Dock-road power station was 26s. 3·66d. per ton in 1933, railages accounting for 20s. of this amount.

At present at the Salt River station water circulates from the sea at the rate of 2,000,000 gallons per hour, and at Dock-road station the circulation is about 750,000 gallons; but the new station, when completed, will require a circulation of approximately 10,000,000 gallons an hour; hence the necessity for the new station to be located within easy reach of an abundance of calm, clean water of low temperature. It is proposed to erect the station in three progressive stages, other machines being installed as required after the first two, until there will be five with a total capacity of 200,000 kW.

An Electro-magnetic Fatigue Tester.

A NEW type of fatigue tester for steel bars which can also be adapted for testing non-magnetic metals has recently been developed by Salford Electrical Instruments, Ltd., an associated company of the General Electric Company, Ltd., of London. In this apparatus the sample bar is supported at its two nodes and vibrated electro-magnetically in order to cause it to resonate, a method of testing which allows a very great number of cycles of stress to be applied to the bar in a relatively short time. By measuring the deflection of the bar at an antinode, the actual stress applied can be calculated from a knowledge of Young's modulus, which can be determined from the frequency of the vibrating bar. The number of cycles applied to the test bar before failure can be indicated by a recorder. A means of tripping the whole gear is provided to operate on the occurrence of a crack in the specimen. More than one bar may be vibrated at the same time by providing several units, and the different failure times caused by varying the stress in each can all be indicated on the chart of one recorder.

The complete apparatus comprises three parts—the bar holder and electro-magnets, the power supply unit, and the recorder. The bar is supported in vee notches, and is rubber covered at the points of support to obviate chattering caused by the imperfection of the mechanical contact. For non-ferrous metals it is necessary to provide steel sleeves over the test bar in the region of the exciting magnets, and a small steel clip in the centre for a pick-up. The electrical circuit uses an A.C. supply, which is transformed for filament heating and rectified for supplying a gas-filled relay anode and the D.C. polarising magnets. The electro-magnets for vibrating the bar consist of two pairs of coils on two iron circuits. One pair of the coils is excited by D.C. and provides a constant polarising field. The other pair is excited by alternating current from the gas-filled relay circuit, in which the relay with its condensers and inductances forms a variable frequency oscillator. This oscillator can be adjusted so that the electrical frequency corresponds to the natural mechanical frequency of the bar. When this correspondence occurs the bar resonates with a relatively large amplitude, and is held in synchronism by means of a pick-up under the centre of the bar, which is connected in the grid circuit of the relay.

In order to trip the circuit on a crack occurring, an auxiliary vibrator is provided. This vibrator consists of a length of steel spring, the tension of which can be adjusted to vary the natural frequency, and is excited from the same circuit as the main A.C. coils. After the main circuit has been tuned the auxiliary vibrator is tuned by varying the tension and then detuned slightly by a half-turn backwards of the tension screw, the natural frequency being thereby lowered, so that no appreciable vibration occurs. On a crack appearing in the specimen the natural frequency is reduced, and the auxiliary vibrator comes into action, vibrating with an amplitude sufficient to touch a fixed contact. This contact closes a local circuit and short-circuits part of the resistance in the grid filament circuit, causing the gas-filled relay to take an increased anode current, which trips a small circuit breaker. The unit is thereupon shut down, and the corresponding pen of the recorder is lifted up, so that the record indicates the point at which the particular bar has failed. The recording drum is driven by a synchronous motor, supplied from the oscillator, which vibrates the lowest stressed bar. As the time of operation or the number of cycles endured varies over wide limits, a logarithmic scale of cycles is necessary in order to cover the range, which for steel bars may be taken as about 10^4 to 10^8 cycles.

The standard fatigue tester is designed for ½in. round steel bars of 18in. length, for which the natural frequency is between 250 and 300 cycles per second. Modifications of the distance between centres, &c., are required for other dimensions. The apparatus may also be adapted to deal with non-uniform loads and the application of a fixed bending load or torsion at the same time as the vibratory stress.

Mechanical Properties of Matter.*

By IRVING LANGMUIR.

THE remarkable advances in physics in recent years have been such as to arouse wonder and admiration from even the layman. The relativity theory, cosmic rays, and the uncertainty principle have furnished the newspapers with subject matter for many front-page columns.

The pace at which these discoveries proceed seems to be ever accelerating. Just within the last year or so many new fundamental particles have been discovered, such as the neutron, the positron, and now, the neutrino. When we think how much our knowledge of chemistry and physics has been increased by the atomic theory, it would seem that the existence of still other particles must be of corresponding importance in the future development of science. These are, in fact, days of the greatest excitement for the physicist. The enthusiasm which permeates the pioneer in this field stimulates the young graduate student to try his hand at similar discoveries.

The advance of modern physics to-day resembles in many ways the motion of an ameba. This small animal sends out pseudopodia in various directions. If one of these protuberances happens to extend toward some attractive morsel, the organism, through something analogous to a sense of smell, becomes excited. The other pseudopodia are withdrawn and the whole mass of the ameba flows into the pseudopod which received the encouragement. In the case of the ameba this process is very effective in taking the animal to its food.

The physicists of to-day behave in a similar way; they all tend to crowd into the extreme outpost, thereby withdrawing from other sectors. Of course, all analogies fall down if pushed too far. It may be objected that the advance in physics differs from that of an ameba in that it leaves a trail behind it. It is true, however, that the physicists do not seem to be aware of the need of adequately developing the side branches from their path of progress. Such work has too often been carried on by engineers without much further help from the physicist.

The quantum theory has led the physicist on to new fields. Obviously, since it gives an understanding of the structure of atoms, it should revolutionise our ideas of chemistry. The physicist, however, is as a rule not interested in the chemical aspects of his work, and very few chemists are familiar with the details of the quantum theory. Thus progress is slow. According to newspaper comment, the distinctions between physics and chemistry are fast breaking down. Actually, this is true only in a narrow field that lies at the borderline between these two sciences. The chemist and the physicist have different habits of thought and different types of interest. How fundamental these distinctions are is illustrated by the fact that of the approximately 2700 chemists listed in "American Men of Science" (1927 edition), only 2·5 per cent. are members of the American Physical Society. On the other hand, only 3·3 per cent. of the 760 physicists belong to the American Chemical Society. There is obviously not much overlapping of interest. Evidently, therefore, physicists themselves are not going to take the trouble to revolutionise chemistry.

In speaking recently before a group of graduate students of the Massachusetts Institute of Technology I pointed out that the physicists were losing a great opportunity. A large part of the men who are working for doctor's degrees in physics are now undertaking theoretical rather than experimental work, and the problems that they are attacking are not those that enable a man to earn a living unless he continues to work in a university or is able to get some sort of fellowship. The physicists often complain of the fact that the number of physicists in this country is so small that they have great difficulty in supporting the physical journals that they publish. The American Physical Society has only about 3000 members, whereas the American Chemical Society has about 17,000.

There is to-day, I believe, a great opportunity for men who will train themselves in modern physics and who will then devote their lives to the applications of the new physics to the study of the properties of matter. By this I mean, not new and unfamiliar properties, but the old-fashioned properties which were being studied fifty years ago.

In 1880 to 1890 a great deal of work was done in investigating the surface tensions of liquids. Lord Rayleigh alone published over a dozen papers on this subject. In 1915 I received a letter from him, saying that he discontinued this work about 1892 because nobody seemed to take any further interest in it. My own work on surface tension and surface chemistry resulted merely from the attempt to understand these surface phenomena in terms of the atomic theory, merely applying the accepted ideas of chemical structure and of the nature of the forces exerted by atoms.

I feel that there are many other fields which have been neglected for many years, where similar application of even the atomic theory would lead to a new understanding. The difficulty is that at present the fundamental mechanical properties of matter do not much interest either the physicist or the chemist, and yet the ideas of both chemistry and physics should be the means of developing our knowledge of these properties.

There are some cases, of course, where problems of this kind are being attacked successfully. For example, the mechanical properties of rubber are being correlated with the chemical and physical structure of rubber. In Schenectady we are trying to do the same thing with the various other plastic materials and condensation products.

In the study of the mechanical properties of metals and ceramic materials modern physical and chemical theories should prove to be of the greatest value. For example, if a finely divided material, such as tungsten, reduced from its oxide by hydrogen, is heated to high temperature it gradually sinters together. The phenomenon of sintering is of great importance in metallurgy, and particularly so in the ceramic industries. I believe that no fundamental work on the nature of this process has been undertaken. The attempts at an understanding of lubrication and adhesion have been very superficial.

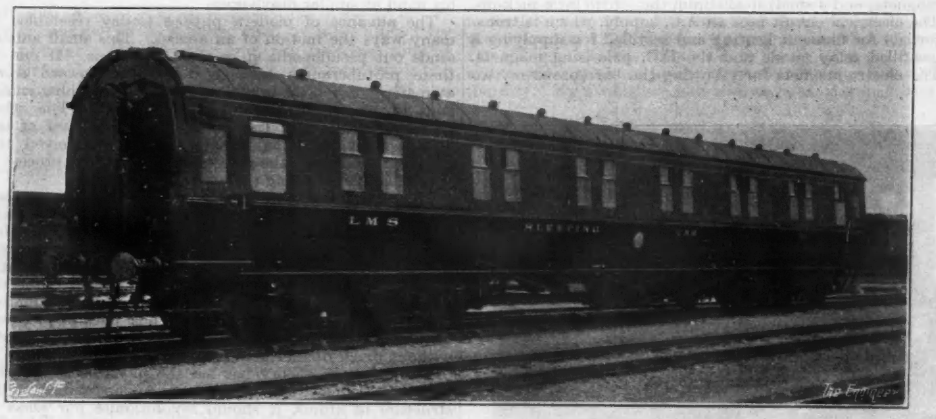
What I urge is that the mechanism in such processes be studied until it is well understood. This would probably at first not need anything much more than the atomic theory. Later, however, a still better understanding of all such phenomena could be developed by the modern physical concepts of the quantum theory.

I venture to predict that during the next ten or twenty years discoveries of great importance will be made in developing materials having new mechanical properties by the applications of modern physics and chemistry.

* From an address delivered at Cincinnati, June 20th, 1935, to the American Society of Mechanical Engineers.

New First-class Sleeping Cars, L.M.S.R.

The London, Midland and Scottish Railway has recently put into service the first of an order for twenty-six first-class sleeping cars, which are being constructed at the Wolverton works. These vehicles, which have been designed by Mr. W. A. Stanier, chief mechanical engineer, embody several new features, including electric arc welded bogies and underframes. The length of the cars is 69ft. 1in. over the body and the width 9ft. 3in. at the waist. The cars have twelve separate berths, each pair having a communicating door, and there is also a lavatory and attendant's compartment situated at opposite ends of the car Externally, the cars follow the company's standard practice in general outline.

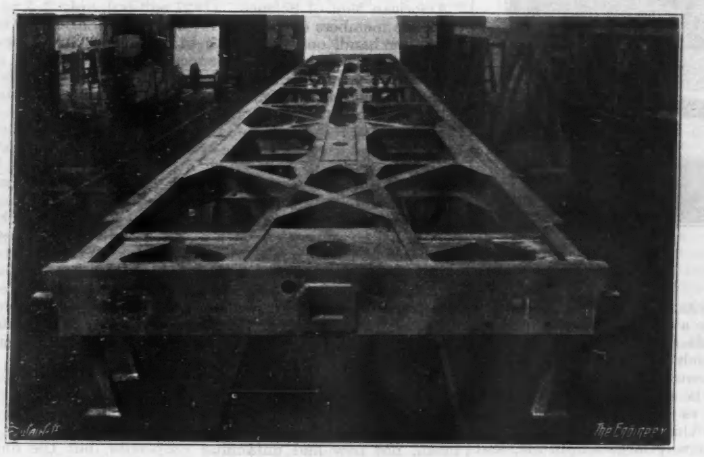


NEW L.M.S. FIRST-CLASS SLEEPING CAR

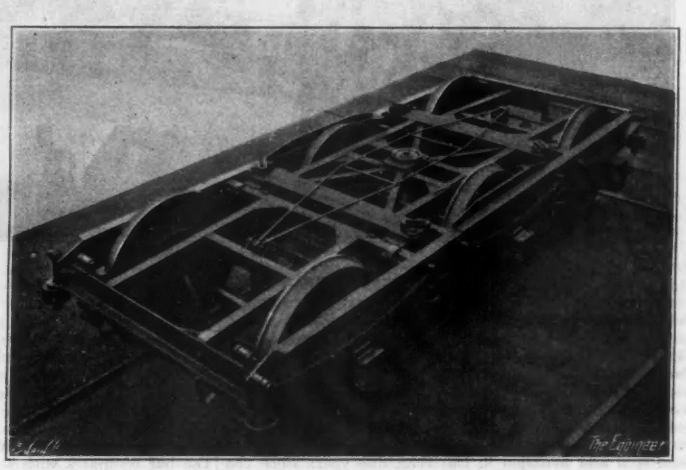
The design of the electric arc welded bogies and underframes is based on the standard method of construction, in order that standard L.M.S. brakework, springs, &c., may be used. The bodies are built directly on to the underframe on a new patented principle, the body pillars being secured in steel box brackets, which are welded to the sole-bar and cant rails, the latter being of angle section steel. The floor is made of steel dove-tail sheeting and cork, the former being welded to the top flange of the sole-bar and adjacent members of the underframe. To reduce track noises, &c., the underside of the floor is sprayed with asbestos to ¼in. thick. The brakework consists of two 24in. single cylinders and two auxiliary vacuum reservoirs. The body framing is mainly of teak, with the exception of the cant rails, roof angles, arch rail angles, corner pillars and end doorway pillars. The sides, roof and ends are covered with No. 16 S.W.G. steel panelling, the body side having a flush finish.

The berth compartments are finished in "Rexine." Each berth has a sliding extractor ventilator light and a sliding shutter with louvres running on spring-loaded pulleys. The wash basin is housed in a cabinet at the foot of the bed, with the feed pipes hidden behind the finishing. A full-length mirror is fitted to the inside of each corridor door leading into the berth. Other details of the furnishing will be gathered from our engravings. The corridor is finished in walnut and sycamore. A lavatory with hot and cold water supply is provided at one end of the car. The attendant's compartment is fitted with a tea boiler and a circulating boiler, the latter providing hot water to the berth compartment wash basins.

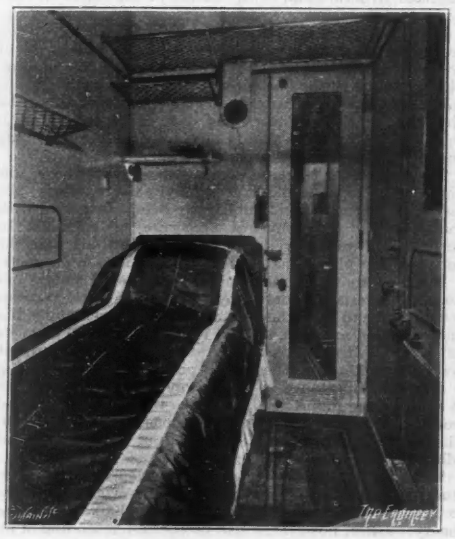
A combined heating and ventilating system of the induced air type is installed, manufactured by Thermotank, Ltd., of Glasgow, and fitted with that company's "Thermo-Reg" control. Each berth has a Punkah louvre, fixed over the head of the bed, by means of which the passenger has individual control of both the volume and temperature of the air entering the compartment. The air stream issuing from the louvre can also be directed to any part of the berth, as desired. The capacity of the air heater is sufficient to maintain an adequate temperature in the berths, but to meet the wishes of passengers who desire another source of heat, each berth has also a steam tubular heater at the floor level controlled by a wheel valve attached to the heater. The electric lighting is by means of the L.M.S. standard "Wolverton" system, which consists of a variable-speed dynamo, a regulator, and a battery of twelve lead-acid cells of 250 ampère-hours capacity. All the lighting is by means of 15-watt pearl lamps. There is a lamp on the ceiling and one over the mirror on the side wall, in addition to a reading light in the corner over the head of the bed. In the corridor, above each berth door, there is a drop indicator for the bell circuit, which is coupled through another indicator, and a bell in the attendant's compartment. The attendant's indicator is arranged to show whether the call has originated from the car or from the adjacent car on either side. The total weight of each car is about 41 tons 16 cwt.



WELDED UNDERFRAME



WELDED BOGIE



INTERIOR OF BERTH

BERTH AND WASHSTAND

SIXTY YEARS AGO.

The relative merits of coupled and single locomotives still provided sixty years ago a field for a wide diversity of opinion among railway men. In a leading article on the subject in our issue of August 20th, 1875, we commented upon the remarkable fact that the railway locomotive appeared to possess an astounding power of adapting itself to circumstances. Heavy goods engines with small drivers had before now, we wrote, been beaten on their own ground by express passenger engines while goods engines in the hands of enterprising drivers had in an emergency been made to keep perfect time with express trains. Among the many points concerning the design and construction of the locomotive which although apparently of vital importance still remained entirely unsettled the question of coupled or single engines continued to be discussed on a basis of pure theory. On some lines the coupled engine was growing in favour while on others there was a tendency to revert to the single engine. In some cases it had been found that single engines could be made to take the place of the coupled engines which had for years been used to conduct a given traffic. On one great line the single engine, we were assured, was found to save about 3 lb. of coal per mile or about 10 per cent. of the entire passenger engine coal bill. The change from coupled to single engines had been made possible by the adoption of steel rails and a strong road. With these improvements it was possible to carry as much as 16 tons on a single pair of drivers. Reviewing the principal factors affecting the problem we came to the conclusion that engines with wheels over 6ft. 6in. in diameter need never be coupled while wheels under 5ft. 6in. ought always to be coupled. For wheels intermediate between these two dimensions the decision whether to use a coupled or a single engine should be made with an eye to various circumstances. If the road were good and tolerably level and the climate dry coupling was best dispensed with. If the road were bad and yielding, permitting the rail to deflect and thereby leading to a redistribution of the load, coupling could be resorted to with advantage. These remarks we said were intended to apply only to engines used on fairly long runs and not to the exceptional conditions prevailing on metropolitan railways on which it was necessary to get the trains away quickly from the stations.

CATALOGUES.

Demag A.G., Duisburg, Germany.—Particulars of pile-drivers and extractors and rock-breakers.

British Thomson-Houston Company, Ltd., Rugby.—A booklet, "Electricity on the Farm."

British Insulated Cables, Ltd., Prescot, Lancs.—"Railway Electrification Brochure No. M 53."

Spencer (Melksham), Ltd., Melksham, Wilts.—An illustrated publication on mineral handling plant.

Peter Brotherhood, Ltd., Peterborough.—Publication No. G.C. 35, describing air and gas compressors of all types and sizes.

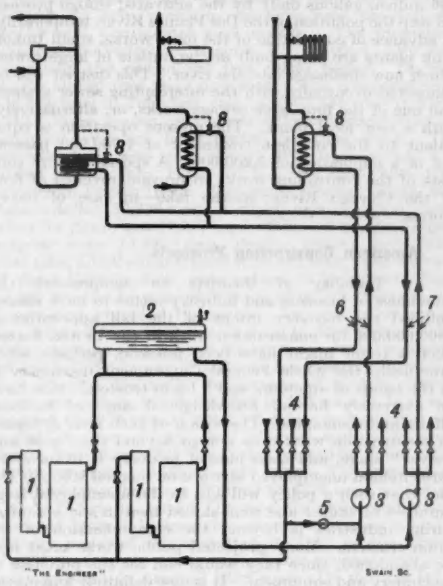
United Steel Companies, Ltd., 17, Westbourne-road, Sheffield, 10.—A new publication on "Red Fox" heat-resisting steels.

Lancashire Dynamo and Crypto, Ltd., 94, Petty France, S.W.1.—An illustrated catalogue describing the firm's geared motor units.

The Velox Hot Water Boiler.

By E. S. DEAN, B.Sc. Tech.

Within the last year three heating plants have been installed on the Continent which are of particular interest in that they incorporate the Velox system of hot water generation developed by Brown Boveri and Co.—the British licensees are Richardsons, Westgarth and Co., Ltd., of Hartlepool. A detailed description of the Velox boiler is not possible within the scope of this article, and



1. *Velox Boiler with preheater.*
2. *Compensating tank.*
3. *Circulator pump.*
4. *Distributor.*
5. *Mixing valve.*
6. *Outgoing and incoming pipe, for hot water for heating purposes.*
7. *Outgoing and incoming pipe for domestic purposes.*
8. *Hot-water-thermostat control.*

Fig. 1—*Diagrammatic Arrangement of Velox Hot Water Generators and Calorifiers.*

in any case it is probably not necessary, as the Velox steam generator has been dealt with very fully in the technical Press during the last two or three years. In particular, there is the paper given by Mr. M. G. S. Swallow before the Institution of Mechanical Engineers on March 27th, 1934,* and that given by Mr. Adolph Meyer before the Institute of Fuel on April 25th, 1934.

From the technical point of view, the most interesting of the three installations is probably that at the Cantonal Hospital at Aarau, Switzerland, and this plant will therefore be described in some detail.

The hospital itself is built on what is called on the Continent the pavilion system, and it consists of twenty-two individual buildings distributed over a large area, and served by a single heating plant. Hot water at 185 lb. per square inch gauge and saturation temperature is used for transmitting the heat through the system to the calorifier stations located in the various buildings. The use of hot water under high pressure is in itself somewhat of an innovation. It has the following advantages, as opposed to steam heating:—Smaller diameter pipe lines may be used with a resulting reduction in first costs and radiation losses; better control of the temperature is possible, and all drains and traps are eliminated. The calorifiers serving the various buildings with hot water for heating and domestic purposes and with steam for cooking and sterilising are all thermostatically regulated, and are also remote-controlled from the central plant.

A diagrammatic arrangement of the Velox boilers feeding the calorifiers for domestic and heating purposes is shown in Fig. 1. For simplicity, the electric boilers and accumulators have been omitted.

Fig. 2 shows the two Velox units as installed, and Fig. 3 gives a section through one of the boilers. On the right of this latter figure is the combustion chamber with the burner and retractable ignition coil at the top and the tubular heating elements arranged as a water wall round the combustion chamber shell. On the extreme left is the

Fig. 2—Velox Hot Water Boilers at Aarau Hospital

The hot water generating plant is, however, the most interesting part of the installation, as it incorporates two oil-fired Velox boilers, each of 28,000,000 B.Th.U. per hour capacity, two electric boilers, each of 10,000,000 B.Th.U. per hour, and three accumulators with a total capacity of 63,000,000 B.Th.U. The reasons for this combination of equipment will be appreciated when it is explained that off-peak current at a low rate is available for the greater part of the year, but during certain seasons, and particularly during January and February—that is to say, precisely when the heating requirements are a maximum—it may happen that an insufficient supply or even no supply at all of low-rate current is available. During such periods the oil-fired Velox boilers would be used. The accumulators are provided in order that the maximum possible use may be made of the off-peak current available. In the case of a hospital, continuity of operation of the heating system is a vital necessity, and this, together with the provision for future extensions, explains why such a large total boiler capacity is provided. Actually the peak load in winter for heating amounts to approximately 15,000,000 B.Th.U. per hour and 12,000,000 B.Th.U. per hour for domestic purposes.

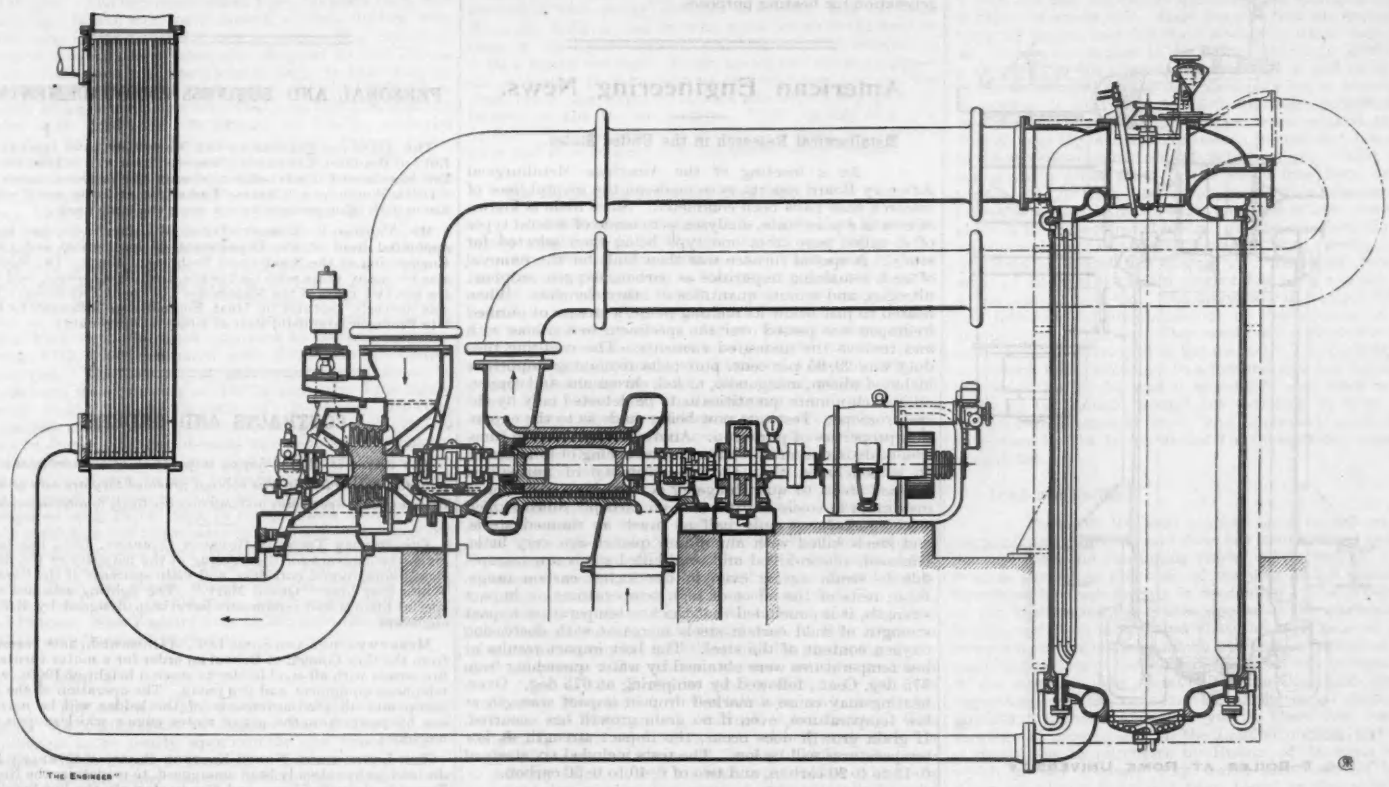


Fig. 3—Sectional View of Velox Boiler Unit

preheater or economiser, and in the centre is the supercharging unit. On the left of this unit is the gas turbine driving the axial flow compressor, and this is coupled through gearing to a variable-speed commutator motor, which is used for starting and regulation. The boilers are put into service, shut down, and regulated by push-button control from the switchboard and interlocks ensure that the operations are carried out in the right sequence. It is interesting to note that in this particular installation the gas turbine at full load generates about 50 kW more power than is required by the air compressor, and this surplus power is fed back into the system through the motor.

The heat release in this type of boiler reaches a value of 700,000 to 900,000 B.Th.U. per cubic foot per hour, and the average rate of heat absorption under normal operating conditions amounts to 110,000 B.Th.U. per square foot per hour. As far as fuel economy is concerned, a thermal efficiency of 87 to 89 per cent., based on the gross calorific value of the oil, is obtained at full load, and there is little variation in efficiency over a wide range down to below 25 per cent. of maximum capacity. Also a feature of these boilers is that they may be

* See The Engineer, April 13th, 1934.

started up from cold and brought to full output in approximately five minutes. A further outstanding point of interest of this equipment is the small space requirements. This will be readily seen from a study of Fig. 2.

This description has been confined mainly to the Velox equipment, as this is an entirely new development in this class of work, but it should be pointed out that the whole installation must rank as one of the finest heating plants in Europe, and well worth closer study by those interested in this branch of engineering.

Another heating installation of outstanding importance is that at the Ciudad Universitaria in Madrid. The university buildings cover an area of about 250 acres, and, as at Aarau, they are served by a high-pressure hot water system fed from a central boiler house.

The boiler house is at present equipped with one oil-fired Velox boiler and one coal-fired Maquinista boiler, each with a maximum output of 53,000,000 B.Th.U. per hour. Recently a second Velox boiler was ordered for this plant, which will bring the total capacity up to 159,000,000 B.Th.U. per hour. The boilers operate at a pressure of 213 lb. per square inch gauge, and saturation temperature, which is about 390 deg. Fah. It should be mentioned, however, that in order to facilitate temperature control with the minimum of loss, provision is made to by-pass the cold return water direct into the suction of the circulator pump by means of the mixing valve 5, shown in Fig. 1. In this way the temperature of the water

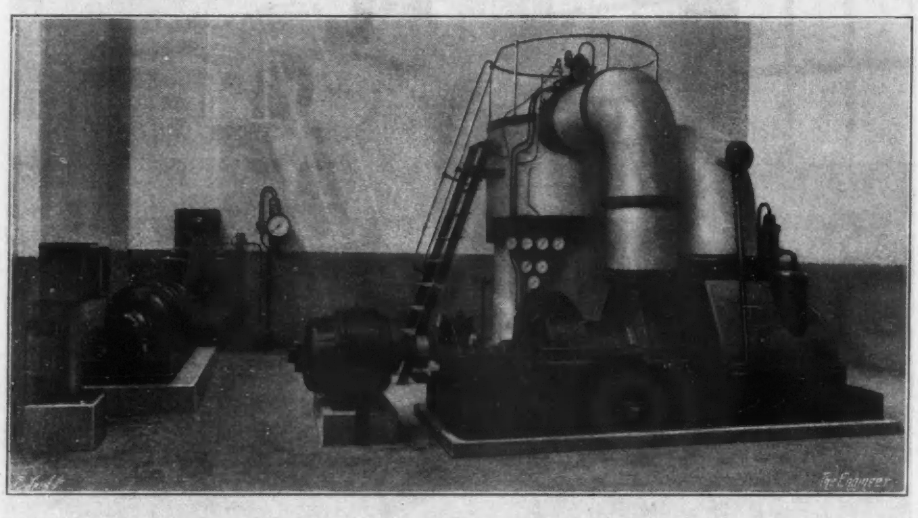


FIG. 4—VELOX HOT WATER BOILER AT MADRID UNIVERSITY

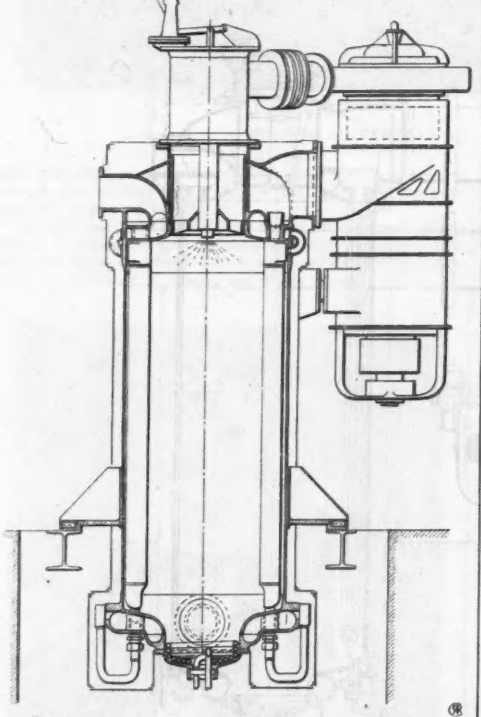


FIG. 5—BOILER AT ROME UNIVERSITY

supply to the system can be controlled, and during times of low demand the maintaining of the full temperature in the system is avoided and radiation losses are therefore reduced.

Fig. 4 gives a view of this Velox boiler. In this particular installation the auxiliary drive to the supercharging unit is a D.C. motor in conjunction with a Ward-Leonard motor generator set, which permits easy and close speed control. In other respects the boiler is the same as those previously described, except as regards the regulation, which in this case is fully automatic.

The third installation which incorporates the Velox boiler is that at the Citta Universitaria in Rome. Two oil-fired Velox boilers are used, each of 16,000,000 B.Th.U. per hour capacity and working at a pressure of 42 lb. per square inch gauge, and a temperature ranging from 180 deg. to 212 deg. Fah., which is thermostatically controlled. In view of the comparatively small size of these units, it has been possible to build the supercharging unit directly on to the boiler itself, thus making a very compact and simple installation. Fig. 5 shows a cross section through the combustion chamber with the vertical auxiliary unit bolted direct on to the flue gas and combustion air connections. The air compressor at the top consists of a single standard radial flow impeller. The gas turbine immediately below it is of the single-stage impulse type, and is connected through gearing to the auxiliary motor. In other respects these boilers do not differ from the larger sizes.

This article would hardly be complete if no reference were made to the heating and power plant at the Federal Technical University in Zürich. Here it has been possible to combine the heating and power requirements, and this is, of course, the most economical system. Furthermore, in view of the fact that the plant is also used as an educational medium, an endeavour has been made to make the equipment as modern and representative as possible; consequently, we see here in the boiler house two electric boilers, a Sulzer Mono-tube boiler, and a large Velox steam generator. The main generating unit is a Brown Boveri 2500-kW double-extraction condensing turbo-generator.

A closer study of this installation is not possible within the scope of this article, but the above notes, together with the foregoing description of the other three installations, will indicate the direction in which progress is being made on the Continent with regard to hot water and steam generation for heating purposes.

American Engineering News.

Metallurgical Research in the United States.

At a meeting of the American Metallurgical Advisory Board reports were made on the several lines of research that have been conducted. Since little is known of iron in a pure state, analyses were made of several types of so-called pure iron, one type being then selected for study. A special furnace was then built for the removal of such remaining impurities as carbon, oxygen, sulphur, nitrogen, and minute quantities of other elements. When heated to just below its melting point, a stream of purified hydrogen was passed over the specimen, to combine with and remove the undesired elements. The resulting product was 99·95 per cent. pure; its remaining impurities included silicon, manganese, nickel, chromium, and copper, all in such minute quantities as to be detected only by the spectroscope. Tests are now being made as to the expansion properties of pure iron. Another subject is the function of deoxidation in relation to the ageing of mild steels. It is concluded that the susceptibility of normalised rimmed steels to quench-ageing is very high, reaching a maximum in steels of 0·04 to 0·05 carbon. Silicon-killed steels quench-age only half as much as rimmed steels, and steels killed with aluminium quench-age very little. Rimmed, silicon-killed and semi-killed steels are susceptible to strain ageing even in the higher carbon range. From tests of the effect of high temperatures on impact strength, it is concluded that the low-temperature impact strength of mild carbon steels increases with decreasing oxygen content of the steel. The best impact results at low temperatures were obtained by water quenching from 375 deg. Cent., followed by tempering at 675 deg. Overheating may cause a marked drop in impact strength at low temperatures, even if no grain growth has occurred. If grain growth does occur, the impact strength at low temperatures will be low. The tests included six steels of 0·15 to 0·20 carbon, and two of 0·40 to 0·50 carbon.

New Sewage Works for Chicago.

There is now approaching completion a system of intercepting sewers and sewage disposal works to provide for the treatment and disposal of all the sewage of Chicago. Just thirty-five years ago the city completed its main drainage canal, which reversed the flow of the Chicago River, so that a flow from Lake Michigan to the Mississippi River diluted and carried away the city's sewage. With the growth of the city and the volume of sewage requiring increased flow for adequate dilution, there was complaint at the heavy draught from the lake, and the necessity of providing for modern methods of sewage treatment became apparent. Under order from the courts, the flow from the lake must be reduced to 1500 cubic feet per second by 1938, so that practically all the sewage must now be subject to treatment. A system of intercepting sewers, including 30 miles of tunnel from 5ft. to 17½ft. in diameter, will connect the ordinary city sewers with four treatment plants. The cost of these plants and the interceptors will aggregate some £42,000,000. The South-West Works will have an activated sludge plant of capacity for treating 400 million gallons daily. The West Works, with 108 Imhoff tanks, is treating 130 million gallons, together with about 2 million gallons of sludge pumped from the West Works through a force main 17 miles long. The new Calumet Works will treat about 136 million gallons daily by the activated sludge process. To stop the pollution of the Des Plaines River, temporarily, in advance of completion of the main works, small Imhoff tank plants are being built at the outlets of large sewers which now discharge into the river. This district will be connected eventually with the intercepting sewer system, and one of the four large sewage works, or, alternatively, with a new local plant. The present operation is equivalent to the complete treatment of 1,700,000 persons out of a population of 5,200,000. A special feature consists of the controlling works to prevent reversal of flow of the Chicago River—to the lake—in case of heavy storms.

American Construction Prospects.

Inability of theorists to comprehend the economics of business and industry seems to have almost nullified the recovery intent of the bill appropriating £800,000,000 for construction work in the United States. Such a result might have been foreseen, perhaps, since practically the whole Federal Government machinery is in the hands of amateurs and "brain trusters," who have an extremely limited knowledge—if any—of business affairs and economics. The vision of such men in regard to construction work does not go beyond the "pick and shovel" stage, and their idea of recovery is to have the three million unemployed at work on manual labour. The fact that such a policy will add to the unemployed large numbers of skilled and semi-skilled men in the manufacturing industries is beyond the comprehension of the brain trusters. Many projected public works must now be abandoned, since they would call for the purchase of machinery and equipment. It is now definitely announced that all work relief projects must be restricted to those on which the expenditure per man per year for labour, materials, and incidentals will not exceed £220, or £280 on highway projects. Furthermore, 90 per cent. of all the workers on a project must be selected from local relief rolls, so that contractors or works superintendents will have their forces composed largely of "green" men. Under such a system there will be inevitably a development of jobs made to spread present employment rather than to effect permanent recovery or to result in needed and valuable public works. Such made jobs have been given the poetic (?) name of "boondogling." The policy thus officially announced is at odds with the President's message, in which he urged that all work undertaken should be useful in the sense that it affords permanent improvement or creates future new wealth. The expected enormous amount of work on public roads will now be limited largely to earthwork—and done mainly by manual labour.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

The Airedale Electrical and Manufacturing Company, Ltd., of Bradford, has recently removed its works to Low Moor, and has deemed it advisable to change the proposed name of "Delta Works" to "Macta Works," in order to avoid confusion with other manufacturers using the same name.

Mr. Thomas B. Morley, D.Sc., M.I. Mech. E., has been appointed head of the Department of Mechanical and Civil Engineering at the Sunderland Technical College. Dr. Morley was for many years with Galloways, Ltd., Manchester, and for the last two years at the Manchester College of Technology. He was formerly Lecturer on Heat Engines and Assistant to the late Professor Archibald Barr at Glasgow University.

CONTRACTS AND ORDERS.

The Editor is always happy to print short announcements of contracts and orders in this column provided they are sent to him in time to have news value and that they are likely to interest readers.

The British Thomson Houston Company, Ltd., has been given the contract for the lighting of the majority of the first-class public rooms, corridors, and main staircase of the Cunard White Star liner "Queen Mary." The lighting schemes and special fittings and equipment have been designed by B.T.H. engineers.

Merryweather and Sons, Ltd., of Greenwich, have received from the City Council of Bristol an order for a motor turntable fire escape with all-steel ladder to reach a height of 100ft., with telephone equipment and fire pump. The operation of the fire pump and all the movements of the ladder will be carried out by power from the petrol motor engine which propels the machine.

The London and North-Eastern Railway Company has decided, as has already been announced, to modernise the North Tyneside electrified lines, and also to electrify the line between Newcastle-on-Tyne and South Shields. A contract for the complete electrical equipment of the rolling stock has been placed with the Associated Manufacturers of Electric Traction Equipment, Ltd., a company in which the following firms are jointly interested:—British Thomson-Houston Company, Ltd., Crompton Parkinson, Ltd., Allen West and Co., Ltd., English Electric Company, Ltd., General Electric Company, Ltd., Metropolitan-Vickers Electrical Company, Ltd. The present contract with the L.N.E.R. will be carried out by Crompton Parkinson, Ltd., as principal sub-contractors in conjunction with Allen West and Co., Ltd., and the British Thomson-Houston Company, Ltd. The contract covers the supply and installation of sixty-four articulated two-car units equipped with two motors, a number of four-motor vans and coaches, together with the control equipment and heating and lighting equipment, as well as the re-equipment of a number of existing vehicles.

Markets, Notes and News.

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer. A comprehensive list of the prices of materials mentioned below will be found on the next page.

The Imports of Iron and Steel.

Interest attaches to the imports into this country of iron and steel materials, as shown in the Board of Trade Returns for July, owing to the agreement between the British and Continental steel makers. The temporary arrangement ended on August 7th, so that July was practically the end of the first quota period. In that month 90,250 tons were imported. This compares with 126,364 tons in July last year, and 63,434 tons in July, 1933. These figures, of course, include imports from all countries, and not from Cartel countries alone. The imports of pig iron reached only 4974 tons in July and 10,908 tons in July, 1934. Of the July total, 4300 tons came from British India. Imports of blooms, billets, and slabs totalled 20,839 tons, a slight increase upon June, when the figure was 17,777 tons. Belgium was the largest supplier with 12,863 tons, France coming next with 7049 tons, and Germany third with 843 tons. The imports of sheet bars in July were substantially reduced from 10,154 tons in June to 5628 tons, of which Belgium and Luxemburg provided the whole. Imports of wire rods also dropped from 7671 tons in June to 3988 tons in July, whilst the figure for general descriptions of steel materials fell from 22,796 tons to 18,263 tons last month. There was also a heavy decline in the imports of girders, beams, joists, and pillars, which totalled 10,153 tons in June and dropped to 5969 tons in July. Belgium as usual was the largest supplier of this class of steel with 2708 tons, France providing 1836 tons, the quantities from other foreign countries totalling 1425 tons. The imports of hoop and strip, however, jumped to 8773 tons, compared with 3827 tons in June. The total for plates and sheets increased from 3118 tons in June to 5532 tons in July. Railway material was imported in July to the extent of 2633 tons, which was a considerable increase upon the previous month's total of 1328 tons. Of the full total Belgium contributed 48,126 tons, the next largest quantity coming from France with 12,956 tons. Luxemburg sent 7609 tons and Germany 6073 tons, whilst the imports from Sweden were 4260 tons, and from Norway 2641 tons. Czechoslovakia, a non-Cartel country, sent 404 tons, whilst the imports from the United States amounted to 925 tons.

A Rise in Steel Exports.

The exports of iron and steel in July, as shown in the Board of Trade Returns, are particularly satisfactory, and were the highest since April. The figures, however, include a number of miscellaneous articles such as stoves, hollowware, deed-boxes, and metal furniture. The exports of pig iron show a slight improvement, the figures for June being 10,559 tons and for July 11,982 tons. Belgium was the best customer and took 2129 tons. The exports of sheet bars, tin-plate bars, wire rods, and bright steel bars showed a small decline from 3161 tons in June to 2903 tons in July. The exports of general descriptions of steel also dropped to 15,353 tons from 17,474 tons in the previous month. In this category British India was the best customer with 3360 tons, South Africa coming next with 2387 tons, and New Zealand third with 1238 tons, the exports to foreign countries totalling 5011 tons. Exports of girders, beams, joists, and pillars remained almost stationary at 2246 tons, compared with 2072 tons in June. An increase is shown in the exports of plates and sheets not under ⅛in. thick from 11,852 tons in June to 12,929 tons in July. Of this quantity Canada took 1062 tons and India 817 tons. Exports to foreign countries totalled 9308 tons, of which 1104 tons went to Russia. A more pronounced improvement was shown in the exports of black sheets under ⅛in. thick, which rose from 11,722 tons in June to 14,647 tons in July. The Argentine took the largest quantity with 3938 tons, the total exported to foreign countries being 4713 tons, compared with 5996 tons to British countries. The exports of galvanised sheets must be considered disappointing at 19,739 tons, the June figure being 21,559 tons. Exports of tin-plates, however, remained steady at 29,653 tons, compared with 29,586 tons in June. Exports of tubes also showed little change at 20,295 tons from the June total of 20,913 tons. A large increase is shown in the tonnage of railway material sent abroad, which, in July, amounted to 28,206 tons, compared with 18,747 tons in the previous month. The July total included: new steel rails, 16,326 tons; sleepers and fish-plates, 3323 tons; tires and axles, 1647 tons, and railway wheels and axles, 4804 tons. The best customer during July was South Africa with 27,137 tons, India coming next with 18,400 tons, and Canada third with 16,738 tons. New Zealand took 11,369 tons, the Argentine 10,311, and Denmark 9146 tons.

Pig Iron.

The activity which ruled in the pig iron market during the earlier part of August has slackened, and conditions more nearly approximate the usual August trading. This month is generally regarded as a "dead" period, but the many changes which took place in the steel industry during the summer, and anticipations of advances in pig iron prices have stimulated business to an unusual degree this year. The market is now settling down, and the fact that most of the large consumers have covered their requirements for some months ahead is likely to operate against any important buying for a time. This week the holidays on the North-East Coast interfered with local deliveries of Cleveland pig iron, although production at the furnaces was not interrupted, and the Scottish works continued to take steady deliveries. Stocks in the makers' yards are small, and as the position with regard to nearly all kinds of pig iron is rather tight, additions to stocks resulting from holiday stoppages will be welcomed rather than the reverse. Recently there were expectations that the price of Cleveland iron would be advanced, but it seems to be generally understood that any decision regarding prices has been deferred by the makers until the autumn. In the Midland pig iron market new business has not been on an important scale, probably owing to the buying movement in July when a number of long-term contracts were arranged, in some cases extending over the end of the year. It is reported that one or two of the producing concerns are not accepting fresh business, owing to the crowded state of their order books. The light castings makers are taking good deliveries, but the demand from this industry so far this year has not come up to expectations, although lately a steady improvement has been noticeable. The requirements of the engineering industry have been expanding for some time, and now represent a substantial tonnage. There is no special feature in the pig iron market in Scotland. The demand remains steady, and no doubt is entertained that it will continue to increase as the year progresses. In the Lancashire market consumers are taking good deliveries, but there is not much new business about. The hematite market is quiet, but this is not surprising, in view of the heavy buying which took place immediately before the recent advance in prices.

Scotland and the North.

The Scottish iron and steel trades are now feeling the benefits of protection. Nearly all departments are well employed, and some are operating full time. New business has not come to hand during the past week on the same scale as immediately before the holidays. There was then a fair amount of forward contracting and a number of consumers filled their near requirements. New orders for ships have provided fresh work for the steel makers, and at the same time the constructional engineers have secured contracts which will keep them busy for some time. There has been a distinct improvement, also, in the position at the bar iron mills, which are more steadily employed than for many months past. Quotations are at the longstanding level of £9 15s. for Crown bars, d/d Glasgow, with No. 3 and No. 4 bars at £7 10s. to £8 respectively, less rebate. Re-rollers are well supplied with orders, and the majority of the works are operating full time. The restriction upon Continental imports, and the fact that the stocks of Continental material held in Scotland have been largely distributed, combine greatly to improve the situation at the mills. Although there have been some fresh sales of Continental steel during the past fortnight, the quantities have not been sufficient to make any impression upon the market. The sheet manufacturers are fairly busy, and as a number of ships are now being completed at Clyde yards and have reached the stage at which a considerable tonnage of sheets is required, the demand from that quarter is making itself felt. Export trade in this material, also, is rather better. In the Lancashire market the chief feature is the steady demand for joists and sections. Business, however, has been far more active in the heavier than in the light sections, and deliveries to consumers total a heavy tonnage. Boiler plates and ordinary plates are in rather poor request at the moment, and for the time being the export markets are not showing much interest in the former quality. It is possible that the demand from overseas will not develop until the markets have had time to assimilate the recent price changes.

The North-East Coast and Yorkshire.

All the steel works on the North-East Coast are busily employed, and although holiday conditions have naturally affected the markets, they have done so to a lesser extent than usual. The producers of semis have enough orders on their books to keep them busy for the next few months. The demand for structural steel, which has been a feature of the market for some time, shows no signs of weakening, and nearly all the constructional engineers have good orders in hand and a large amount of potential business in view. The orders placed on the North-East Coast early in the summer for ships are now being reflected in better deliveries to the shipyards. There is room for a considerable improvement in the shipbuilding industry on this Coast, and it is hoped that fresh orders will be secured shortly. Most of the sheet works are moderately well occupied on contracts with home users. The export demand, however, is not good, although during the past week or two a few fair-sized transactions have been reported. Considerable interest has been aroused by the report that the Cargo Fleet Iron Company, Ltd., proposes to erect a sheet rolling mill. This followed closely the announcement that Dorman, Long and Co., Ltd., intended to lay down plant of this description and that Rd. Thomas and Co., Ltd., would erect at their works in Lincolnshire a continuous rolling mill for producing sheets and tin-plates. The rather quieter conditions which have ruled in the Yorkshire steel markets this and last week may be ascribed to the holidays. All the works, however, are busy, and the outlook is satisfactory. The demand for basic steel billets is on a heavy scale and it is reported that some works are finding it difficult to keep to delivery dates. There has been some decline in business in bright-drawn steel, but users of strip continue to take heavy quantities and some good inquiries have been in circulation. One of the features of the market since the arrangement with the Continent has been the activity in the home wire rod department.

Current Business.

The London Passenger Transport Board has placed an order for 58 steel carriages for the Underground railways with the Birmingham Railway Carriage and Wagon Company, Ltd., and with the Metropolitan-Cammell-Weymann Motor Bodies, Ltd., for 200 trollybus bodies. The Liverpool Refrigeration Company, Ltd., has obtained an order from Alfred Holt and Co. for a complete CO_2 refrigerating plant for the steamer "Flintshire." The Atlas Diesel Company, Ltd., has recently received nine orders for Diesel engines for various vessels now building. J. and W. Kirkham, Ltd., Bolton, are supplying lubricators for the Richardsons-Westgarth double-acting, two-stroke engines to be fitted to the motor ships "Silverlarch" and "Silverpine," which are now being reconstructed. A number of orders for oil-purifying equipment have been secured by the Alpha-Laval Company, Ltd. The Pather Iron and Steel Company's works at Wishaw have been purchased by the Motherwell Machinery and Scrap Company, Ltd., a subsidiary of George Cohen and Sons, Ltd., London, for demolition. Hurst, Nelson and Co., Ltd., of Motherwell, have received orders for 200 coal-carrying wagons of 12 tons capacity from collieries in Fife and Yorkshire. An order for 131 steel coaches has been awarded by the London and North-Eastern Railway Company to the Metropolitan-Cammell Carriage and Wagon Company, Ltd., of Saltney, Birmingham. The order is in connection with the electrification of the railway company's Newcastle-upon-Tyne and South Shields line. The Department of Overseas Trade reports that the following contracts are open for tender:—Indian Stores Department: Diesel locomotive, 2ft. gauge (Simla, September 24th). Argentine, State Oilfields Directorate: Two steam "Duplex" injection pumps, approximately 14in. by 7½in. by 18in., for a working pressure of 126 atmospheres (1800 lb. per square inch), and a steam pressure of 18 atmospheres (250 lb. per square inch) (Buenos Aires, September 26th); National Sanitation Works Department: Electric generating set, consisting of a Diesel-engine-driven 250 kVA alternator, three electrically driven centrifugal pumping sets, and nine electrically driven piston pumping sets, each for deep-well service, together with auxiliaries and accessories (Buenos Aires, September 24th). Siam, Royal State Railways: 200,000 kilos. of pig iron (Bangkok, September 13th). South African Railways and Harbours: Boiler stay taps and reamers, twelve 4-ton electrically driven portal-jib cranes and spares for Table Bay Docks, two 5-ton steam-driven travelling cranes of the self-propelling swing-jib type, each equipped with a suitable lifting magnet (Johannesburg, September 9th).

Copper and Tin.

The market for electrolytic copper has developed considerable activity this week, and buying particularly in America has been on a heavy scale. In other countries also consumers have shown an inclination to cover their requirements. No doubt this change in the market arises to a great extent from the strained international political situation. It is impossible to foretell the effects of hostilities in Abyssinia on the copper market, and naturally consumers are taking the precaution to cover their potential needs. Copper prices in America have been advanced to 8·50 c. d/d, and the export quotation has strengthened to 8·12½ c., or about £37. Italy has not been an important buyer of copper, and the State Monopoly which has been set up does not appear to be fully organised. Difficulty with regard to the purchase of exchange is said to be one of the troubles which the new Monopoly has to overcome. According to statistics which have been published in America, the world stocks of copper were reduced during July by over 20,000 tons. American consumption increased to 45,025 tons against 36,020 tons in June, whilst consumption in other parts of the world rose from 84,760 tons to 89,775 tons. American production increased by just over 3000 tons, but a slight decrease of 300 tons took place in the foreign production. In the standard market considerable activity has prevailed, and prices have advanced on speculative buying. . . . The chief development of interest in the tin market has been a sharp rise in the price of cash tin. The downward movement which had followed the announcement of the increase in the quota ceased at the end of last week, and a much stronger tone has since developed in the market. The backwardation which had diminished to a few shillings has increased this week to £9 5s., and it is evident that there is not likely to be enough prompt tin available to meet the market's requirements until the increased production authorised by the International Tin Committee comes on the market.

Lead and Spelter.

Prices in the lead market have moved within narrow limits this week, and there has been a rather quieter demand from the consuming trades. The decline, however, is normal at this time of the year and is generally succeeded by fresh buying in September. The prospects of the lead-consuming trades appear to be particularly bright, and it is anticipated that the high rate of consumption in this country which has been a feature of the position practically throughout this year will be regained in the autumn. The situation on the Continent also is improving, and the consumption of the metal shows an important increase over last year. There has been a shortage of prompt lead in the London market, but this is partly due to purchases by Russia of Mexican lead, which in the ordinary way would have arrived here. Some grumbling has again been heard at the apparent shortness of the supplies of Empire lead, which do not seem sufficient to meet the needs of consumers. . . . No feature of interest has developed in the spelter market, and the price remains depressed and at about £1 below the lead quotation. It is not often that the spelter value remains for long below that of lead, and the general impression seems to be that a price advance in this market is overdue. The arrivals of foreign spelter this month have been small, probably owing to the improvement in the Continental consuming industries. According to American statistics, the consumption of spelter is steadily increasing in practically all countries. The stocks in the United States at the end of July are given as 115,723 tons. The production during the month was 35,055 tons, whilst the deliveries amounted to 32,241 tons.

Current Prices for Metals and Fuels.

Makers' official home trade prices, per ton, delivered buyers' stations. Sections, joists and plates are subject to a rebate to home users purchasing only from associated British Steelmakers: joists, 22s. 6d.; plates and sections, 15s. Export orders of 250 tons and over may be subject to special quotations.

PIG IRON.

	Home.	Export.
	(*D/d Teesside Area*)	
N.E. Coast—	£ s. d.	£ s. d.
Hematite Mixed Nos.	3 10 6	3 2 0
No. 1	3 11 0	3 3 6
Cleveland—	(*D/d Teesside Area*)	
No. 1	3 10 0	3 4 0
No. 3 G.M.B.	3 7 6	3 1 6
No. 4 Forge	3 6 6	3 0 6
Basic (*Less 5/– rebate*)	3 10 0	—
Midlands—		
Staffs.—	(*Delivered to Black Country Station*)	
North Staffs. Foundry	3 11 0	—
„ „ Forge	3 6 6	—
Basic (*Less 5/– rebate*)	3 15 0	—
Northampton—		
Foundry No. 3	3 7 6	—
Forge	3 2 6	—
Derbyshire—		
No. 3 Foundry	3 11 0	—
Forge	3 6 0	—
Scotland—		
Hematite, f.o.t. furnaces	3 11 0	—
No. 1 Foundry, ditto	3 12 6	—
No. 3 Foundry, ditto	3 10 0	—
Basic, d/d (*Less 5/– rebate*)	3 10 0	—
N.W. Coast—	3 14 6	d/d Glasgow
Hematite Mixed Nos.	3 18 6	„ Sheffield
	4 4 6	„ Birmingham

MANUFACTURED IRON.

	Home.	Export.
Lancs.—	£ s. d.	£ s. d.
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
S. Yorks.—		
Crown Bars	9 12 6	—
Best Bars	10 2 6	—
Midlands—		
Crown Bars	9 15 0	—
Marked Bars (Staffs.)	12 0 0	—
No. 3 quality	7 10 0	—
No. 4 „	8 0 0	—
Scotland—		
Crown Bars	9 12 6	9 5 0
Best	10 2 6	9 15 0
N.E. Coast—		
Common Bars	9 12 6	8 15 0
Best Bars	10 2 6	9 15 0
Double Best Bars	10 12 6	10 0 0

STEEL.

London and the South—	Home.	Export.
	£ s. d.	£ s. d.
Angles	8 10 0	7 7 6
Tees	9 10 0	8 7 6
Joists	8 17 6	7 7 6
Channels	8 15 6	7 12 6
Rounds, 3in. and up	9 10 0	8 7 6
„ under 3in.	8 14 6	7 0 0
Flats, 5in. and under	8 14 6	7 0 0
Plates, ¼in. (basis)	9 0 0	7 15 0
„ ⅜in.	9 5 0	8 0 0
„ ½in.	9 10 0	8 5 0
„ ⅝in.	9 15 0	8 10 0
„ ¾in.	9 10 0	8 5 0
North-East Coast—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Plates, ¼in.	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 5 0	—
Midlands, and Leeds and District—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates, ¼in.	9 7 6	7 15 0

STEEL (*continued*).

Glasgow and District—	Home.	Export.
	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 6
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 15 0	7 15 0
„ ⅜in.	9 0 0	8 0 0
„ ½in.	9 5 0	8 5 0
„ ⅝in.	9 10 0	8 10 0
„ ¾in.	9 5 0	8 5 0
Boiler Plates	9 5 0	—
South Wales Area—	£ s. d.	£ s. d.
Angles	8 7 6	7 7 6
Tees	9 7 6	8 7 6
Joists	8 15 0	7 7 0
Channels	8 12 6	7 12 6
Rounds, 3in. and up	9 7 6	8 7 6
„ under 3in.	8 12 0	7 10 0
Flats, 5in. and under	8 12 0	8 17 6
Plates, ¼in. (basis)	8 17 6	7 15 0
„ ⅜in.	9 2 6	8 0 0
„ ½in.	9 7 6	8 5 0
„ ⅝in.	9 12 6	8 10 0
„ ¾in.	9 10 0	8 5 0

Ireland—	Belfast.	Rest of Ireland.
	£ s. d.	£ s. d.
Angles	8 12 6	8 15 0
Tees	9 12 6	9 15 0
Joists	9 0 0	9 2 6
Channels	8 17 6	9 0 0
Rounds, 3in. and up	9 12 6	9 15 0
„ under 3in.	9 2 0	9 4 6
Plates, ¼in. (basis)	9 0 0	9 2 6
„ ⅜in.	9 5 0	9 7 6
„ ½in.	9 10 0	9 12 6
„ ⅝in.	9 15 0	9 17 6
„ ¾in.	9 12 6	9 15 0

OTHER STEEL MATERIALS.

	Home.	Export.
Sheets.	£ s. d.	£ s. d.
10-G to 13-G., f.o.r.	9 10 0	8 15 0
14-G. to 20-G., d/d	10 15 0	9 0 0
21-G. to 24-G., d/d	11 0 0	9 5 0
25-G. to 27-G., d/d	11 12 6	9 17 6

The above home trade prices are for 4-ton lots and over; 2-ton to 4-ton lots, 10s. per ton extra; and under 2-ton lots, 30s. per ton extra.

Galvanised Corrugated Sheets, Basis 24-G.

Home.	£ s. d.
4-ton lots and up	13 0 0
2-ton to 4-ton lots	13 7 6
Under 2 tons	15 0 0

Export: £12 15s. 0d., c.i.f. India.
„ £11 5s. 0d., f.o.b. other markets.
„ Scandinavian Markets free.

Tin-plates.
20 by 14 basis, f.o.b. Bristol Channel Ports, 18/2.
Tin-plate Bars, d/d South Wales Works, £5 5s. 0d.

Billets.	£ s. d.
Basic (0·33% to 0·41% C.)	6 12 6
„ Medium (0·42% to 0·60% C.)	7 2 6
„ Hard (0·61% to 0·85% C.)	7 12 6
„ „ (0·86% to 0·99% C.)	8 2 6
„ „ (1% C. and up)	8 12 6
Soft (up to 0·25% C.), 500 tons and up	5 10 0
100 to 250 tons	5 17 6
Rails, Heavy, 500-ton lots, f.o.t.	8 10 0
„ Light, f.o.t.	7 10 0

FERRO ALLOYS

	Per Ton.	Per Unit.
Tungsten Metal Powder	3/3 per lb.	
Ferro Tungsten	3/– per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 15 0	7/–
„ „ 6 p.c. to 8 p.c.	£21 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£21 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£34 0 0	11/–
„ „ „ 1 p.c. carbon	£36 5 0	11/–
„ „ „ 0·50 p.c. carbon	£37 5 0	12/–
„ „ „ carbon free	9½d. per lb.	
Metallic Chromium	2/5 per lb.	
Ferro Manganese (loose)	£10 15 0 home	
„ Silicon, 45 p.c. to 50 p.c.	£12 15 0 scale	5/– p.u.
„ „ 75 p.c.	£17 17 6 scale	6/– p.u.
„ Vanadium	12/8 per lb.	
„ Molybdenum	4/6 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£200 to £205	
Cobalt	5/6 per lb.	

NON-FERROUS METALS.

Official Prices, August 21st.

Copper—		
Cash	£33 7 6 to £33 8 9	
Three months	£33 15 0 to £33 16 3	
Electrolytic	£36 15 0 to £37 10 0	
Best Selected Ingots, d/d Birmingham	£36 15 0	
Sheets, Hot Rolled	£64 0 0	
	Home.	Export.
Tubes, Solid Drawn (basis)	10d.	10d.
„ Brazed (basis)	10d.	10d.
Brass—		
Ingots, 70/30, d/d Birmingham	£29 0 0 to £31 0 0	
	Home.	Export.
Tubes, Solid Drawn, 2/1 Alloy	9½d.	9½d.
„ Brazed	11½d.	11½d.
Tin—		
Cash	£225 10 0 to £226 0 0	
Three months	£216 5 0 to £216 10 0	
Lead: Cash and forward	£16 2 6	
Spelter	£15 0 0 to £15 5 0	
Aluminium Ingots (British)	£100	

FUELS.

SCOTLAND.

Lanarkshire—	Export.
(f.o.b. Grangemouth)—Navigation Unscreened	13/– to 13/9
„ Glasgow—Ell	14/6 to 15/–
„ „ Splint	17/– to 17/6
Ayrshire—	
(f.o.b. Ports)—Steam	12/6 to 13/–
Fifeshire—	
(f.o.b. Methil or Burntisland)—	
Prime Steam	13/6 to 14/–
Unscreened Navigation	13/6 to 14/–
Lothians—	
(f.o.b. Leith)—Hartley Prime	13/– to 13/6
Secondary Steam	12/– to 12/6

ENGLAND.

Yorkshire, Manchester—	
B.S.Y. Hard Steams	18/6 to 21/6
Furnace Coke	13/– to 16/–
Northumberland, Newcastle—	
Blyth Best	13/6 to 14/–
„ Second	13/3 to 13/6
„ Best Small	10/6 to 11/–
Unscreened	12/6 to 13/6
Durham—	
Best Gas	14/8
Foundry Coke	19/– to 20/–

Sheffield—	Inland.
Best Hand-picked Branch	23/– to 25/–
South Yorkshire Best	20/– to 22/–
South Yorkshire Seconds	17/– to 18/6
Rough Slacks	8/– to 9/–
Nutty Slacks	7/– to 8/6

SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Admiralty Large	19/6
Best Seconds	19/– to 19/4½
Best Dry Large	18/9 to 19/3
Ordinaries	18/3 to 18/6
Best Bunker Smalls	12/6 to 13/6
Cargo Smalls	11/6 to 12/6
Dry Nuts	22/– to 26/–
Foundry Coke	27/– to 40/–
Furnace Coke	19/– to 22/6
Patent Fuel	21/–
Swansea—	
Anthracite Coals:	
Best Large	36/– to 40/–
Machine-made Cobbles	41/– to 48/6
Nuts	40/– to 48/6
Beans	25/– to 30/–
Peas	19/– to 23/–
Rubbly Culm	11/– to 11/6
Steam Coals:	
Large Ordinary	18/– to 20/6

FUEL OIL.

Inland consumption; contracts in bulk.
Exclusive of Government tax of 1d. per gallon.

Ex Ocean Installation.	Per Gallon.
Furnace Oil (0·950 gravity)	3½d.
Diesel Oil	4d.

French Engineering Notes.

(From our own Correspondents in Paris.)

Export Trade.

THE expected reaction of engineering industries against the suppression of quotas has not manifested itself for the reason that in the present state of affairs the decrees appear to offer the only hope of salvation, and because the extent of the protection to be afforded to industry by them will be determined by the French Import Duties Advisory Committee after examining the claims of each branch of industry in relation to the possible effect of such protection on the general interest. A solution of the problem is more difficult in this country than it is elsewhere because there are so many interests involved of a conflicting nature. Manufacturers will insist upon the highest protection obtainable, but they cannot impede efforts to open up foreign markets which are essential to industrial recovery. There are reports of industrial improvement in all big producing countries except France, and manufacturers see that they can only hope to escape from their present dilemma by participating in what appears to be a growing international trade. Monetary stability and high production costs place competitive business in most European markets almost out of the question for the time being. Enterprise is being directed, particularly by machinery makers, to Eastern markets where plans for an efficient commercial organisation have been put in hand. Those plans should prove effective when arrangements are completed to provide facilities for an export trade. Meanwhile, there is evidence of rather more activity in some of the engineering branches, owing almost entirely to State requirements and public works, and belief in a revival of confidence and private enterprise following upon the Government's attempt to effect a national economic reorganisation with a developing foreign trade leaves industrialists more hopeful of the early future.

Training Mechanics.

There are complaints that when engineering firms require skilled hands they find difficulty in obtaining them from the large number of men who apply for jobs. It is alleged that there is a scarcity of good mechanics, which is explained by the fact that since it was found necessary to repatriate foreign workers in order to deal with the unemployment problem the number of specialised mechanics has fallen to a level that is likely to cause embarrassment when industrial activity revives. Foreign labour had to be imported to make up for the deficiency of French skilled workmen, and such importation was all the more necessary for starting new industries for which native specialised hands were not available. Arrangements had, therefore, to be made for a development of the apprenticeship system which was formerly left, to a large extent, to employers themselves. The introduction of new social legislation governing workshops and factories imposed restrictions on employers that made it difficult to carry on the old system of apprenticeship in works, and big firms were obliged to provide special shops for the training of youths to be employed by them. This is done by leading engineering and automobile firms and by the railway companies. The results obtained are satisfactory, because the training is adapted to specialised work in particular branches of industry, and the French mechanic has usually a natural aptitude for work requiring precision and initiative. The number of men capable of being turned out in this way is limited. Training schools have therefore been established by employers' associations, municipalities, Chambers of Commerce, and by private bodies authorised by the State. They are entitled to grants from a fund supplied by a tax on employers who do not train apprentices. The facilities for training are ample, and yet the results fail to come up to expectations, for the reason, partly, that many schools with their diplomas tend to leave an impression amongst apprentices that they can attain to other positions than work at the bench. They have not the same mentality as youths who begin their careers in works. Employers affirm that the system needs better organisation, and they also object to the apprenticeship tax being devoted to other purposes than the financing of approved training schools.

Colonial Transport.

One of the problems that are being dealt with in the organisation of the Colonial Empire is the provision of transport facilities between Algeria and the Niger Valley with the idea of promoting trade. The Trans-Saharan railway scheme has been abandoned. It is proposed to replace it, partly, with air services carrying goods and passengers, and in February next a technical congress will be held at Bamako, on the Niger, when a first air caravan is expected to arrive there with goods from Algeria. Apart from the economical aspect of transporting goods by air, those who know French West Africa and the requirements of its sparse native population doubt whether it can offer a profitable market for Algerian products, but Monsieur Charles Roux, who recently undertook a second mission to that colony by way of the Sahara, which he traversed both ways with motor cars running on various colonial fuels, is convinced of the possibility of developing trade in the Niger territory with the aid of motor cars running on fuels derived from vegetable oils. He installed a laboratory at Bamako, and a fuel factory is being erected at Segou by the Government of French West Africa.

Iron and Steel Production.

Returns published by the Comité des Forges of the iron and steel production during June last show a notable diminution compared with the corresponding month of 1934. The output of raw steel was 503,000 tons, a reduction of 9000 tons. In rolled steel, rails declined from 26,000 tons to 22,000 tons, joists from 49,000 tons to 39,000 tons, and merchant bars from 107,000 tons to 98,000 tons. The production of pig iron in June was 465,000 tons, compared with 509,000 tons in the similar month of last year. There were eighty-two furnaces in blast out of a total of 211.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., 1s. each.

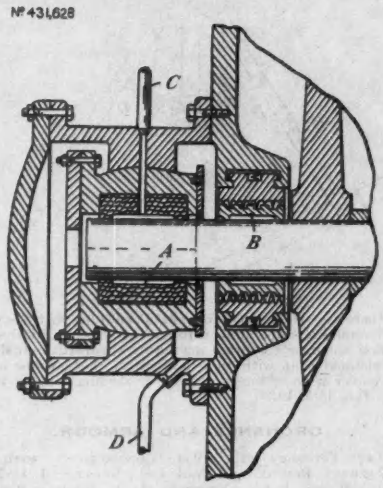
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

TURBINE MACHINERY.

431,628. February 4th, 1935.—BEARINGS FOR STEAM TURBINES, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

This turbine bearing is made either of fibrous material united by artificial resin or of bronze impregnated with graphite, and

Nº 431,628



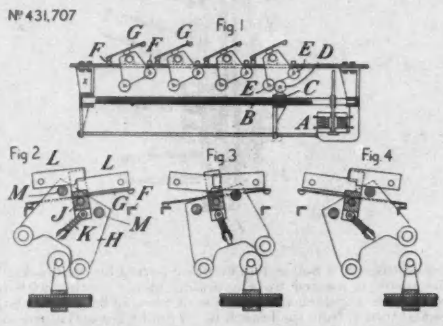
is lubricated by water. The bearing, which is split horizontally, is shown at A and the labyrinth packing gland at B. The lubricating water is supplied at C, at a pressure approximating to the steam pressure in the turbine casing, and is discharged at D. Any steam which may leak through the gland is condensed and carried away with the water.—*July 11th*, 1935.

SWITCHGEAR.

431,707. January 15th, 1934.—MEANS FOR MECHANICALLY OPERATING A NUMBER OF ELECTRIC SWITCHES, Allmänna Svenska Elektriska Aktiebolaget, Västeras, Sweden, Alf Schaanning, White Cottage, The Uplands, Loughton, Essex, and H. Nutt, 27A, The High-road, Buckhurst Hill, Essex.

This apparatus is intended for operating the switches of a booster transformer voltage regulating system, and is worked by the split phase induction disc (Ferraris) type motor A, which runs at a slow speed with constant current. This motor drives

Nº 431,707



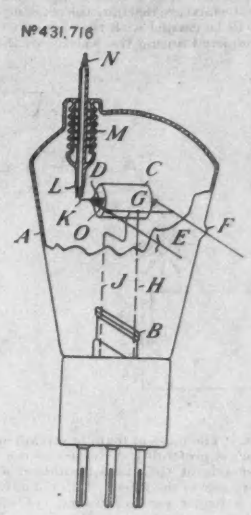
the screw B on which there rides the traveller C. This traveller is provided with a roller D that operates the switches in turn by coming in contact with the rollers E E. The electrical circuit contacts are shown at F F, and the contacting brushes at G G. The details of the switch mechanism are more plainly indicated in Figs. 2, 3, and 4, which show successive positions. The brush arms G are pivoted between the cheek plates H of the switch at J, and are thrown over abruptly by the snap action of the spring K. The locking plates L L, which are operated by the lugs M M, prevent the brush arms from stalling and producing arcs in the case of misadventure.—*July 15th*, 1935.

ELECTRICAL APPLIANCES.

431,716. February 6th, 1934.—THERMIONIC VALVES, Telefunken Gesellschaft fur drahtlose Telegraphie m.b.H., 12/13, Hallesches Ufer, Berlin, Germany.

This is a thermionic valve suitable for use at very high frequencies equivalent to wave lengths of the order of a decimeter. Referring to the drawing, A is a tubular glass envelope having the usual pinched footstep B, which carries an ordinary concentric cylindrical electrode system having an axial cathode which, for the sake of clarity, is not shown in the drawing. C is an open-ended cylindrical anode containing a concentric grid D consisting of a helically wound wire, the connections to the ends of which are fused through the glass wall at the points E and F, and can be extended as shown in an external parallel wire system. These wires are fixed together by a short-circuiting connector G at the middle of which is fixed a carrier wire H. J is the carrier wire for the anode. One end of the grid is provided with or extended to form a little hook or extension K, which engages the open end of a glass tube L which is fused, as shown, into an elastic relatively flexible ribbed glass tube M, fused to the glass envelope. The tube L is continued outside the envelope to form an external rod N, as shown. With this construction forced movements of the external member N will be transmitted to the glass tube L, and thus to the member K. The mechanical connection between the member K and the short-circuiting conductor G consists of an elastic leaf or flat spring O so that no appreciable resistance is opposed to the movements of the hook K. It is thus possible to produce (by moving the member N) an expansion or compression of the grid

Nº 431,716

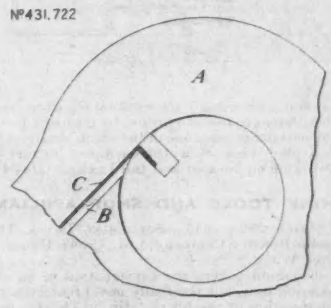


turns in the longitudinal direction, and in this way desired adjustment of the inherent frequency of the electrode system may be achieved.—*July 15th*, 1935.

431,722. February 16th, 1934.—VARIABLE ELECTRIC CONDENSERS, A. C. Cossor, Ltd., and D. G. Rennett, Highbury-grove, London, N.5.

This invention is concerned with fixing the vanes of electrical condensers on the shafts by means of which they are rotated. The vanes A are stamped to shape with a hole slightly larger than the diameter of the shaft. They are also provided with a

Nº 431,722



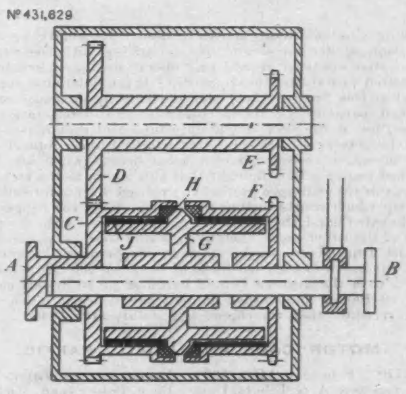
slot B. The vanes are assembled in a jig and a shim plate C, which corresponds with the length of the shaft, placed in the slot. The shaft is then threaded into place and on being turned with respect to the vanes draws in the shim and makes a tight joint. It is suggested that if the diameter of the shaft is 0·25in., and that of the hole 0·252in., the shim should be 0·004in. thick.—*July 15th*, 1935.

TRANSMISSION OF POWER.

431,629. February 4th, 1935.—REVERSING GEARS FOR MARINE ENGINES, V. A. Kjær, No. 10, Ellinorsvej, Charlottenlund, near Copenhagen, Denmark, and J. Braad, No. 1, Fiskerihavnsgade, Copenhagen.

In this reversing gear the driving shaft is shown at A and the driven at B. The driving shaft is provided with toothed

Nº 431,629



gearing C D to operate a chain gear E F. The chain wheel F is loose on the shaft B, but the internal drum G is keyed to the shaft. If the shaft is pushed to the left the cone clutch H engages and by winding the spring J round the drum G provides a direct forward drive. By moving the shaft to the right, reversal is effected in a similar manner.—*July 11th*, 1935.

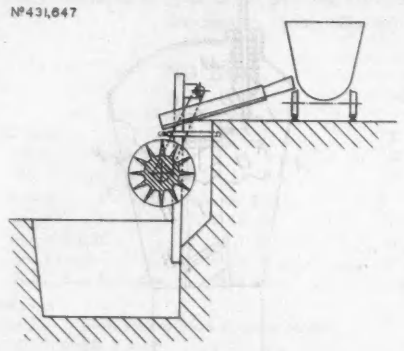
FURNACES.

431,647. January 9th, 1934.—APPARATUS FOR TREATING FURNACE SLAG FOR THE PRODUCTION OF "FOAMED SLAG," Dorman, Long and Co., Ltd., Zetland-road, Middlesbrough, and J. S. Lewis, Tynewald, Petersham, Surrey.

The plant for the production of "foamed slag" the component parts of which are clearly indicated in the drawing, comprises an inclined trough down which a stream of molten slag flows. Adjacent to this trough, and preferably beneath it, a valve-controlled water delivery spout is arranged, this water spout being preferably of approximately the same width as the trough. Beneath the slag trough and the water spout and at some distance from them, a rotating wheel or drum is arranged. The periphery of this wheel or drum is provided with bars or projections, and is so located that the mixture of slag and water in foaming condition falls upon it. The process of foaming starts

in the air and by operating the valve controlling the water supply, the correct proportion of water for effecting the best result can be readily adjusted. Although the foaming begins in the air, it does not follow that complete foaming will be effected prior to the mixture reaching the rotating wheel or drum, but the water will be carried with the slag on to the drum and the foaming completed during the passage of the stream to its

No 431,647



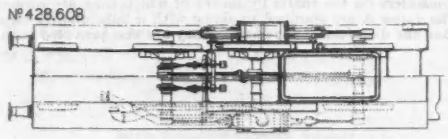
place of deposit. The mass of foam or stream of slag in admixture with water, is preferably delivered to the wheel or drum slightly to that side of the axis of rotation which is remote from the delivery side of the wheel. This not only has the advantage of giving a longer path of travel, but also permits any excess water to drain off the rear side of the wheel.—*July 9th*, 1935.

LOCOMOTIVES.

428,608. November 10th, 1933.—Steam Locomotives, W. C. Werry, Beaulieu, Woodhouse-road, Finchley, London, N.12.

In this steam locomotive the inventor employs cylinders, each of which contains two pistons working in opposition,

No 428,608



with piston and connecting-rods working separate crank axles. Steam is distributed to the two pistons by means of piston valves operated by excentrics from one of the crank shafts. The drawing shows a plan view of a three-coupled engine with the cylinders working on the first and third axles.—*May 10th*, 1935.

MACHINE TOOLS AND SHOP APPLIANCES.

431,637. March 29th, 1935.—Soldering Irons, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2.

This specification covers the construction of an electrically heated soldering iron, but the really novel feature is the metallurgical composition of the bit or "tip." This tip is described as being made of an alloy consisting mainly of copper, but containing a minor quantity of beryllium and the remainder of cobalt. At present the preferred alloy consists of about 97 per cent. copper, about 2·6 per cent. cobalt, and about 0·4 per cent. beryllium. This alloy is treated by heating it for approximately one hour at approximately 900 deg. Cent., and then quenching it in water, and thereafter reheating to approximately 500 deg. Cent. for one or two hours, and then allowing it to cool. The rate of cooling from the 500 deg. Cent. temperature seems to be immaterial, and so it may be air cooled. The working tip formed of the above alloy treated in the above-described fashion, is claimed to be far superior to the copper

No 431,637

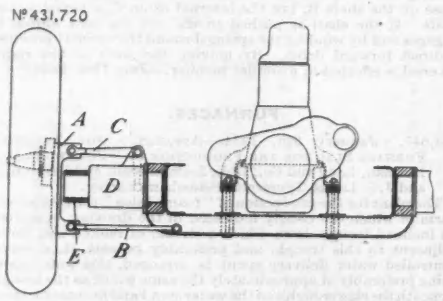
working tips heretofore generally used. Its ability to resist corrosion or decomposition, due to mixing with the various fluxes that are used in soldering operations, is remarkable as compared with that of the copper tip. It is not definitely understood at this time just why the soldering tip possesses such a marked capacity to resist corrosion and deterioration by fluxes, but it has been definitely established that it possesses this characteristic. Likewise, tips arranged in accordance with this invention resist oxidation when heated while idle to a marked degree. It is thought that this is due to the fact that when this tip oxidises a protective oxidised layer is formed over the tip which resists further oxidation. With the copper tip, on the other hand, the oxidised layers peel off when the temperature of the tip changes, thereby exposing fresh copper surfaces to the atmosphere which, in turn, are oxidised. Moreover, this tip has a Brinell hardness of between 200–220, as compared with the average Brinell hardness of 30 in soft copper and 90–100 in cold-worked copper, and hence is much more wear resistant than the copper tips.—*July 11th*, 1935.

MOTOR CARS AND ROAD TRAFFIC.

431,720. February 14th, 1934.—Independent Wheel Suspension, A. G. Elliott, Darley Dene, Belper-road, Derby.

The front wheels of this car are mounted on stub axles fixed

No 431,720



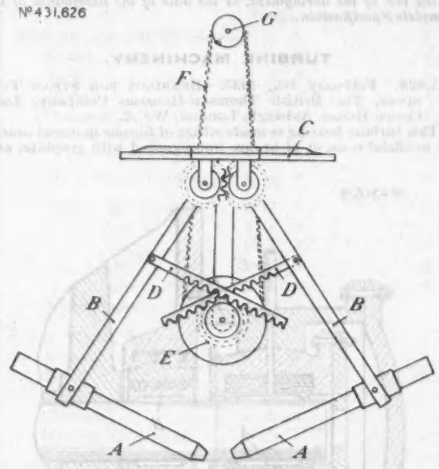
in the frames A. These frames are attached to the chassis by the links B and bell cranks C. The links are slightly longer than the bell cranks in order to maintain the width of the wheel track. The shorter arm of the bell crank bears against a coiled spring in the box D, which also contains a dashpot. A rubber buffer E is provided on the end of the box to support the vehicle in the event of the spring failing.—*July 15th*, 1935.

LIGHTING AND HEATING.

431,626. January 24th, 1935.—Arc Lamps, Körting und Mathiesen A.G., Leipsig Leutzsch, Germany.

In this arc lamp the carbons A A are carried by arms B B pivoted to the base plate C. At their pivots the arms are geared together, so that they make similar angular movements. To the

No 431,626



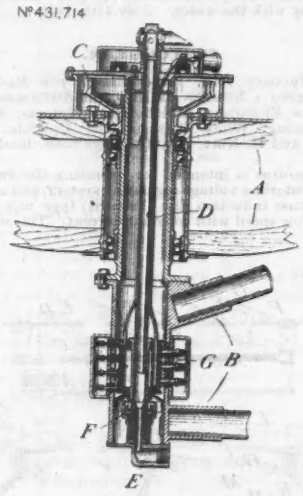
arms there are attached two racks D D meshing with the pinion E. This pinion is operated, through the chain F, by the shaft G, which is connected with a regulating apparatus (not shown). It is claimed that with this mechanism the carbons can be moved over a wide range without hazarding reliable regulation.—*July 11th*, 1935.

ORDNANCE AND ARMOUR.

431,714. February 6th, 1934.—Connections with Gun Turrets, Boulton and Paul, Ltd., Norwich, J. D. North, Hill House, Eaton, Norwich, H. A. Hughes, Westfield, Plumpstead-road, Norwich, and A. Doe, St. Peters, Earlham Green-lane, Norwich.

The connections for operating the revolving gun turret of an aircraft, part of the framing of which is indicated at A, are

No 431,714



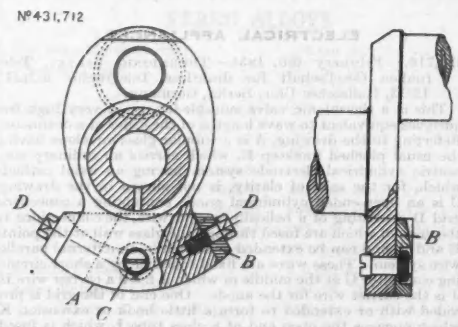
carried through a hollow trunnion, supported by the bracket B. The turret is rotated by a hydraulic motor gearing with the worm wheel C, which is supplied with working fluid through the central tube D from the branch E. A fluid-tight seal is provided at F. Electrical connections are made by means of the brushes G, and slip rings on the central tube attached to the turret.—*July 15th*, 1935.

MISCELLANEOUS.

431,712. February 3rd, 1934.—Balance Weights for Crank Shafts, A. G. Elliott, Darley Dene, Belper-road, Derby.

The inventor dovetails his counterweights on to the crank webs so that centrifugal force tends to secure them more tightly. The counterweight is provided in part by the exten-

No 431,712

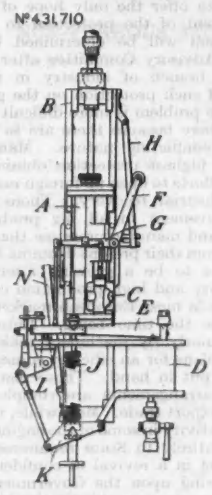


sion A of the web, this extension being of such a size that it does not interfere with the machining of the shaft and webs. The remainder of the balance is provided by the separate part B, which embraces the sides of the extension A with a dovetail-like hold. The weight is held in place by the central bolt C and the set screws D D.—*July 15th*, 1935.

431,710. January 17th, 1934.—Automatic Fluid-operated Regulators, J. Gordon and Co., Ltd., and J. F. Schippers, Regent House, Kingsway, London, W.C.2.

The object of this invention is to provide a spring-loaded pressure-regulating device in which the active length of the spring is automatically maintained constant regardless of its movement. The actuating cylinder A operates the control valve (not shown), through the cross head B. The movement of the cylinder piston is controlled by the servo-motor C. This servo-motor is controlled by the bellows D, connected with the

No 431,710



pressure to be regulated, by the main lever E and floating lever F. The lever F is carried by the bell crank G, which has a returning action by means of the cam plate H attached to the cross head B. The main lever E is loaded by the spring J, the lower fulcrum of which is carried by the lever K. This lever is connected by the linkage L with a roller bearing on the cam plate N, also connected with the cross head B. In this way the length of the spring J is kept constant, regardless of the position of the various parts of the mechanism.—*July 15th*, 1935.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Saturday, Aug. 24th.

North of England Inst. of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. Annual general meeting. A film, "Ground Movements in Advance of Longwalls," will be shown by Mr. A. Walker. 2.30 p.m.

Saturday, Aug. 31st.

Belfast Assoc. of Engineers.—Annual golf competition and bowls match. Golf competition at Castlerock, depart Belfast 9.45 a.m. Bowls match at Portrush, depart Belfast 12 noon.

Wednesday, Sept. 4th.

Manchester Assoc. of Engineers.—Visit to the East Lancashire Paper Mill Company, Ltd., Radcliffe, near Manchester. 2.30 p.m.

Thursday, Sept. 5th.

Inst. of Marine Engineers.—Visit to Metropolitan Vickers Electrical Company's Trafford Park Works, Manchester.

Monday, Sept. 9th, to Thursday, Sept. 12th.

Inst. of Metals.—Autumn meeting and Conference at Newcastle-upon-Tyne. For programme see page 99, July 26th, 1935.

Tuesday, Sept. 10th.

Inst. of Marine Engineers.—85, The Minories, E.C.3. "Marine Electrical Installations in Service," Mr. H. G. Leivesley 6 p.m.

Thursday, Sept. 12th, to Saturday, Sept. 28th.

Shipping, Engineering and Machinery Exhibition (Incorporating the Foundry Trades Exhibition).—Olympia, London, W. Open 11 a.m. to 9 p.m. daily (except Sundays).

Friday, Sept. 13th.

Railway Club.—At Royal Scottish Corporation Hall, Fetter-lane, E.C.4. "Power-operated Signals," Mr. E. Wallis. 7.30 p.m.

Monday, Sept. 16th, to Thursday, Sept. 19th.

Iron and Steel Inst.—Autumn meeting at Manchester. For provisional programme see page 189.

Wednesday, Sept. 18th.

Inst. of Marine Engineers.—Official visit to the Shipping, Engineering and Machinery Exhibition at Olympia, London, W.

Thursday, Sept. 19th, to Saturday, Sept. 21st.

National Smoke Abatement Soc.—Seventh annual Conference at Bristol.

Saturday, Sept. 21st.

Manchester Assoc. of Engineers.—Visit to works of the Renold and Coventry Chain Company, Ltd., Burnage. 2.30 p.m.

Monday, Sept. 23rd.

Inst. of Marine Engineers.—Autumn golf meeting at Shirley Park, East Croydon.

Tuesday, Sept. 24th.

Inst. of Marine Engineers.—85, The Minories, E.C.3. Presidential address, Mr. Maurice E. Denny. 6 p.m.

Wednesday, Sept. 25th.

Inst. of Welding: N. Western Branch.—At School of Technology, Manchester. "Gas-cutting of Metals Prior to Fabricating and Welding," Mr. W. Hart. 7.30 p.m.

Tuesday, Oct. 1st.

Inst. of Automobile Engineers.—At Royal Soc. of Arts, John-street, Adelphi, W.C.2. Presidential address, Mr. A. J. Hancock. 8 p.m.